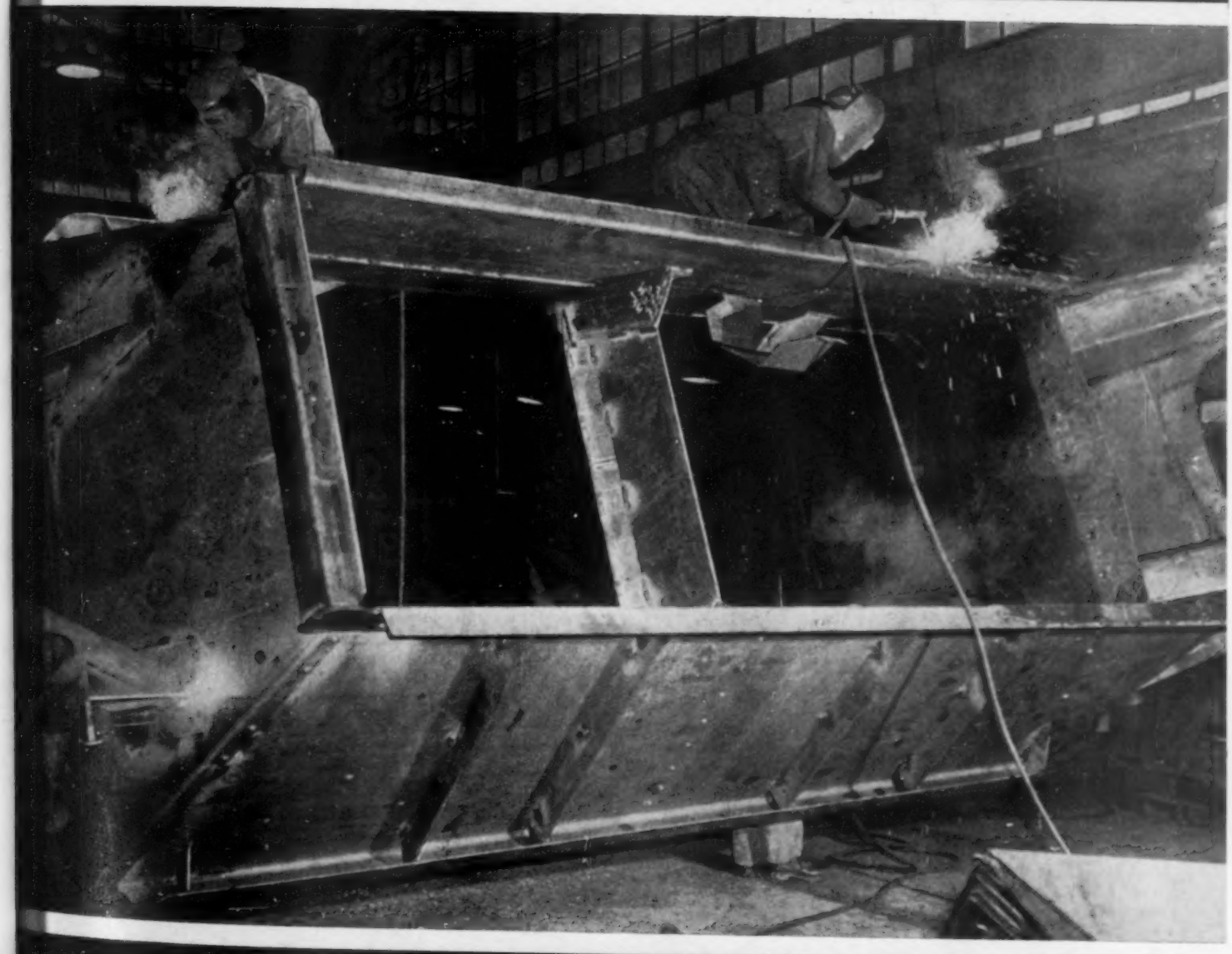
APRIL, 1947

WELDING

Journal



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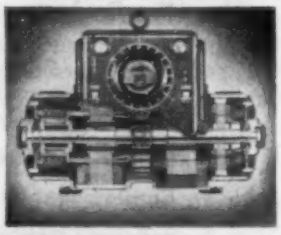

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COVER

A 13-Yard 20-Ton Bottom-Dump Trailer Is Being Welded in Plant of Euclid Road Machinery Co. *Photo, Courtesy General Electric Company.*

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Depositing Overlaid Surfaces by the Submerged Melt Welding Process*

By L. C. Bradburn,† J. M. Keir,‡ J. E. Taylerson§

UNIONMELT welding has aroused considerable interest in the past several years as a means of rebuilding or resurfacing worn machine parts. Most of this work has involved replacing material with weld metal of similar composition or at least of similar wearing qualities. More recently surfacing with dissimilar materials has been undertaken.

Thus far the process has been restricted to rebuilding, but there is a growing interest in its use in manufacturing articles composed of dissimilar materials. The advantages of stainless steel and other alloy surfaces show promise for the extensive use of the Unionmelt process in certain applications. For example, cast steel valves can be surfaced with stainless materials which exhibit better wear and corrosion qualities than those normally obtained from cast steel.

It is understandable that Unionmelt welding is replacing other welding methods in this field, when the economic features of the process are considered. The usual features of rapid welding traverse, minimum vee joint preparation and minimum rod requirements per foot of weld are of little consequence, but the high speeds of rod deposition, high operating factors possible, as well as the advantages of minimum rod loss, minimum subsequent machining and minimum operator fatigue make the process particularly advantageous for surfacing operations. Rod has been deposited at rates higher than 40 lb. per hr. with no stub or spatter loss and frequently Unionmelt equipment is operated more than 80% of the working day without undue operator fatigue. A large Eastern fabricator finds it economical to rebuild the large hydraulic plunger shown in Fig. 1 by Unionmelt welding.

The speed at which metal may be deposited depends almost entirely upon the welding current and the percentage of the time that the machine is actually welding. If rod, welding composition and labor costs are known estimates of cost per lb. of required deposit can be easily made for a particular job, since the limiting current and the maximum operating factors may generally be predicted.

The reproducible results possible and the production adaptability of the Unionmelt process are economic features well worth considering.

Surfacing by any welding method requires the complete fusion of the added material to the base material, and the quantity of material added depends only upon the thickness of the deposit. It is well known that, as usually practiced, Unionmelt welding fuses a large portion of base material which is uniformly mixed with the welding rod. Frequently the quantity of base material fused is twice as much as the quantity of rod fused with normal submerged melt welding technique as shown by Fig. 2. When the purpose is to deposit weld metal, not to fuse base metal, it has been desirable to avoid the usual rod dilution, particularly if dissimilar materials are to be used. Consequently, techniques have been developed for reducing the per cent dilution of rod material with base material, and these are employed when dissimilar materials are to be used.

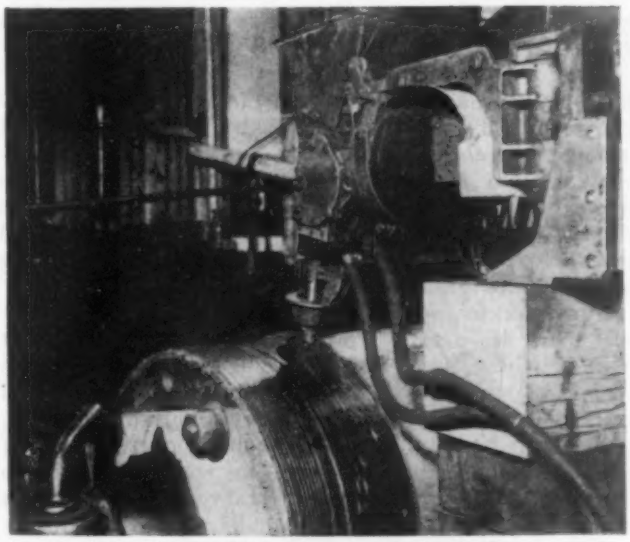

Fig. 1—Rebuilding a 24-In. Diameter Hydraulic Plunger 9 Ft. 2 In. Long by Unionmelt Welding

Figure 3 shows a weld cross section which exhibits proportionately much less base metal fusion than that shown in Fig. 1. It is readily understandable that the chemical composition of the first weld will not be that of the welding rod, but will reflect greatly the composition of the base material. The influence of the parent material on the weld metal analysis is frequently termed per cent rod dilution. The percentage rod dilution and the compositon of the deposit can be approximated mathematically if the known volumes of rod material and base material, as shown by the weld cross section, are considered, and if consideration is given to expected element loss or pick-up caused by the welding process. For example, assume that the fused section of the first weld on

* Presented at Twenty-Seventh Annual Meeting, AMERICAN WELDING SOCIETY, Atlantic City, N. J., Nov. 17–22, 1946.
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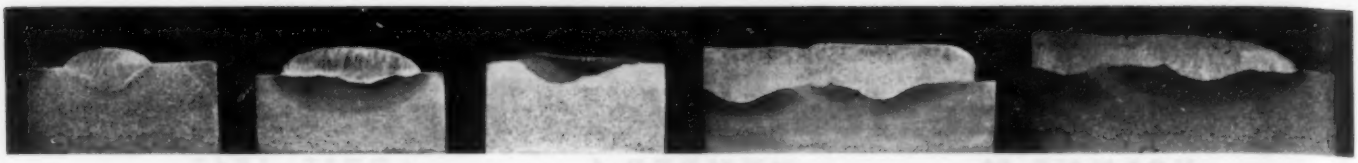

Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6

Fig. 2—Fusion Contour and Depth of Penetration Produced by Usual Unionmelt Welding Technique. Rod Dilution About 45%

Fig. 3—Stainless Steel Deposit of 15.60% Cr, 11% Ni Produced by High Voltage, Low Speed, and Low Welding Current Technique. Rod Dilution Is About 20%

Fig. 4—A Concave Weld Surface Tends to Show Surface Centerline Cracking

Fig. 5—Section Showing a Single Layer of Everdur Deposited on S.A.E. 1045 Plate by Unionmelt Welding

Fig. 6—Type 430 Stainless Steel Deposit on S.A.E. 1045. Weld Metal Analyses Is as Follows: C—0.17%, Mn—0.90%, Si—0.44%, Cr—10.54%

a chrome steel consists of 60% base material and 40% rod, then the chromium content of the deposited material will contain $^{6}/_{10}$ths of the base material chrome content plus $^{4}/_{10}$ths of the welding rod material chromium percentage, minus about 3% which is lost by the welding action.

In order to avoid base metal dilution, welding techniques other than those normally used with the Unionmelt process have been developed. The use of direct current with electrode negative (straight polarity) results in about 15% reduction in penetration, and thus reduces rod dilution. The use of higher welding voltages (about 40 volts), welding speeds of 3 to 5 in. per min. and relatively low welding current densities aid in reducing rod dilution to about 20% as shown in Fig. 3.

In addition to apparent chemical losses due to rod dilution, there are definite chemical losses or gains brought about by the welding action. When welding medium-carbon or low-carbon steel, the carbon content is reduced from 3 to 5 points. In welding steels containing 0.45% carbon with high-carbon rods, as much as 20 points of carbon may be lost. This loss seems to bear little or no relation to the degree of preheat, and only slight relation to welding speed (the lower the welding speed the greater the loss in carbon and the greater the pick-up in manganese and silicon content). The use of grade 80 welding composition reduces this loss in certain instances.

A gain in manganese content of 10 to 15 points over that calculated is experienced with grade 80 material, and only slightly higher with grade 90. No manganese pick-up is observed with grade 20 material.

Silicon pickup amounts to about 30 to 35 points with grades 20 and 90 material and about 20 points with grade 80 material with multipass welding.

Approximately $3^{1}/_{2}$ to 4% chromium is lost in welding with the high chromium rods, while no loss of nickel or molybdenum is noted.

If normal Unionmelt process techniques are used with multipass welding, the deposited weld metal reaches chemical equilibrium after about three layers, and only slight changes are observed thereafter. With high welding voltages, slow speeds and low current densities, equilibrium is approached in the first layer.

In resurfacing machine parts considerable interest has been focused on the hardness of deposited weld metal. The expense of heat treating the finished weld is in most cases prohibitive, which requires that the deposited metal exhibit some predetermined hardness. The range of hardnesses desired varies from about 150 to 500 Bhn. This wide range has been broken down into four small ranges as follows:

The hardness range for each group can be narrowed down somewhat by control of preheat and welding conditions.

		Hardness Range	Applications	Welding Rod	*Unionmelt*
Group	I	150–200	Shafting, piston plungers	Oxweld 36 and 40	Grade 90
"	II	200–300	Crane and mine locomotive wheels	Oxweld 296 and S.A.E. 6150	Grade 80 or 90
"	III	300–400	Rolls for steel mills	Type 501 Stainless	Grade 80
"	IV	400–500	Rolls and special applications	Type 420 Stainless	Grade 90

Control of preheat is essential particularly when making high carbon deposits. An initial preheat of 300° F. min. to 600° F. max. is frequently required, and the degree of preheat must be controlled to prevent excessive heat build-up. If the temperature of the weldment exceeds 600° F. the fused Unionmelt material is difficult to remove and soft deposits will result. On many surfacing jobs, cooling during welding becomes necessary because the heat input of the welding process exceeds the heat normally radiated from the weldment. If this heat is not naturally carried away, the temperature build up caused by the welding process is frequently controlled by air cooling, and water cooling is used when methods can be devised to keep the unfused Unionmelt material dry. This cooling is particularly necessary when making deposits on small weldments where the volume of metal is not sufficient to readily absorb and dissipate the heat.

Maintaining lower weldment temperatures results in harder deposits, but care must be taken to prevent weld cracking, since theh ard high-carbon deposits are relatively brittle. Aside from preheat, weld cracking can be avoided by preventing notch effects caused by irregular bead width and by maintaining proper fusion contours. Weld beads that change rapidly in width or that show notches at the edges due to faulty operating technique tend to crack transversely at the notches which are effective stress raisers. If the bead surface is excessively concave, surface centerline cracking appears. If the weld bead tends to be excessively convex, subsurface cracking occurs. Figure 4 illustrates the former condition. Skillful operation of equipment tends to eliminate cracking caused by improper fusion contours.

Deposits with carbon content as high as 0.60% have been made. Such deposits are made with high-carbon low-alloy materials. Thus far it seems impracticable to make crack-free deposits containing more than 0.40% carbon with plain carbon rods, even if the rod contains as high as 1% carbon. With medium-carbon and high-carbon low-alloy rods, crack free deposits can be made which are equally as hard or harder than straight high-carbon deposits. Oxweld No. 40, 296, and Type 501 stainless rods fall into this classification.

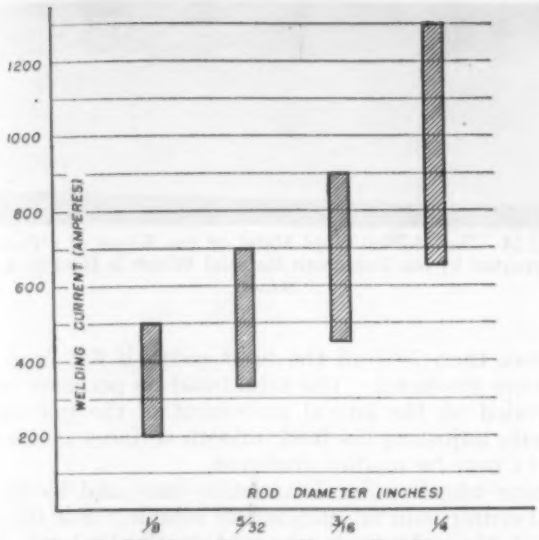

Fig. 7—Welding Current Versus Rod Diameter

Deposits made with Type 420 stainless steel show the greatest hardness with crack freedom of any of the materials tried. This material is relatively expensive and, therefore, is used only when one or two layers are necessary. With proper control of welding conditions, hardnesses in the range previously given (400–500 Bhn.) may be obtained in a single pass on medium carbon steels.

Flame hardening of weld deposits is usually too costly, but this method has been used occasionally. Deposits made with Oxweld No. 40 welding rod and grade 90 Unionmelt material will flame harden to about 300 Bhn. Since the depth of flame hardening is relatively shallow, it is necessary to perform any required machine work before flame hardening.

Everdur shows some promise as a surfacing material, although to date there have been no production applications. Figure 5 shows a cross section of an Everdur deposit made on S.A.E. 1035 plate. The average surface hardness of this deposit is 135 Bhn., and the chemical analysis of the deposit is: Mn 0.77, Si 2.41, Fe 14.24, balance copper.

Stainless steel deposits can be made in similar fashion as shown in Fig. 6. The use of the Unionmelt process for surfacing with stainless steel has been proposed for fabrication where clad materials are not applicable. The surfacing of hydroelectric-plant impeller wheels is a possible application.

From an economic standpoint it is desirable to use the maximum welding current possible. The maximum is determined by the rod size and by the diameter of the workpiece, if the workpiece is cylindrical. Figure 7

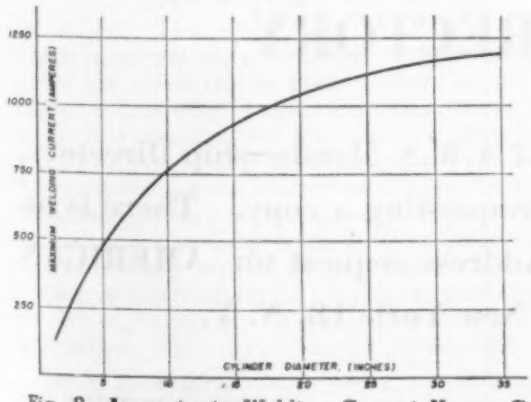

Fig. 8—Approximate Welding Current Versus Cylinder Diameter

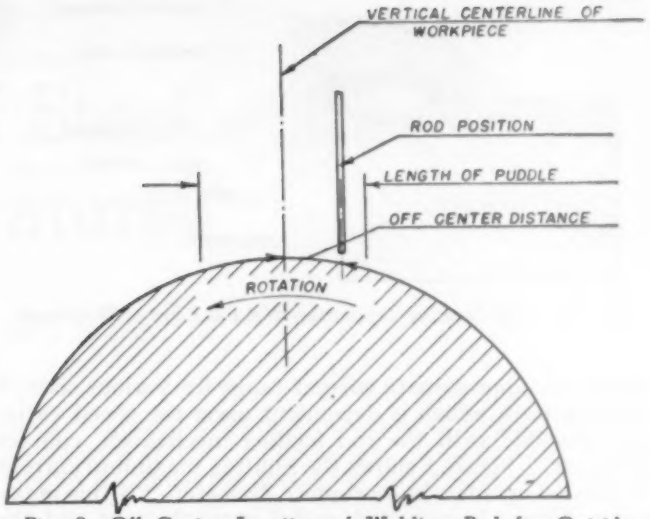

Fig. 9—Off Center Location of Welding Rod for Outside Cylindrical Welding

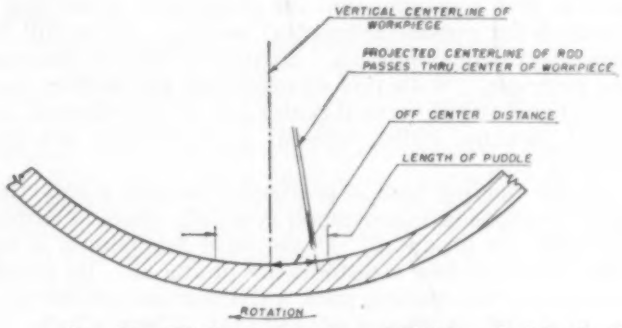
VERTICAL CENTERLINE OF WORKPIECE
PROJECTED CENTERLINE OF ROD PASSES THRU CENTER OF WORKPIECE
OFF CENTER DISTANCE
LENGTH OF PUDDLE
ROTATION

Fig. 10—Off Center Location of Welding Rod for Inside Cylindrical Welding

Fig. 11—Flat Beads Can Be Produced by Properly Setting the Welding Rod Off Center

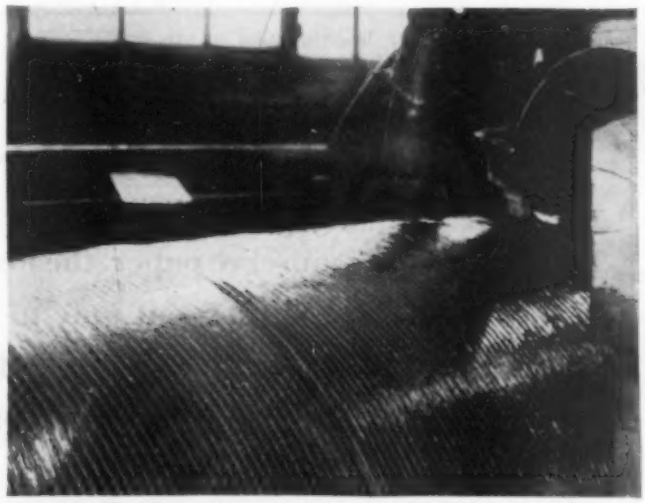

Fig. 12—The Smooth Surface Shown Is Controlled by Properly Setting the Lateral Rod Movement

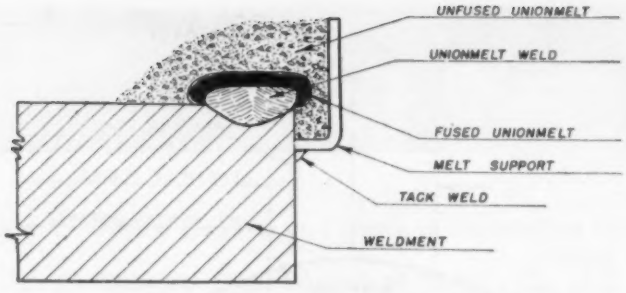

Fig. 13—Melt Dam for Supporting Weld at Edge of Weldment

Fig. 14—The Molten Weld Metal on the Edges of a Plate Is Supported by the Unionmelt Material Which Is Held by a Retainer

shows the approximate current range for various sizes of welding rods, which is dependent upon the speed variation possible with the rod feeding mechanism, contact jaws, etc. Figure 8 shows the limiting maximum current as plotted against the workpiece diameter. If this maximum current is exceeded, metal runouts occur and the bead is produced with an undesirable shape.

Cylindrical welding requires that the welding rod be positioned away from the top or bottom vertical center line, in such a manner that the progression of welding is downhill for outside cylindrical welding, and uphill for inside cylindrical welding. Figures 9 and 10 illustrate the principle. With this arrangement, the welding pool is centered on the vertical center line of the cylinder, and metal runouts, either forward or backward, are prevented.

If the welding pool is positioned in such a way that weld progression is too much downhill, concave surface contours are produced. If the weld progression is uphill, convex surface countours are produced. By proper location of the welding pool, a flat surface contour may be produced as shown in Fig. 11. These effects are apparently caused by surface tension and gravity.

Similar effects can be produced on flat surfaces by positioning the workpiece for welding uphill or downhill, as desired.

When welding on cylindrical objects requiring a continuous layer of deposited metal, a spiral overlapping bead is generally used. The distance the rod is moved transversely per revolution is equal to about $^1/_2$ of the bead width for the normal convex bead contour, and may be more than 75% of the bead width if flat bead contours are produced. The total build-up per layer can be controlled by the lateral movement of the rod and by properly adjusting the feed, smooth surfaces as shown in Fig. 12 may be readily produced.

Crane wheels, mine locomotive tires and locomotive wheel centers can be successfully rebuilt. For this type of work the rod may be moved laterally by hand at the completion of each turn of the wheel. Similar principles apply to welding flat surfaces.

Lateral flow of the large Unionmelt welding pool must be prevented when welding the edges of a surface. The necessary lateral support of this pool can be readily accomplished with the Unionmelt material. Figure 13 illustrates one method. The retainer is usually made of sheet metal. However, it can be made of any non-metallic substance that can be suitably formed. The function of the retainer is to support the unfused Unionmelt material which must be deep enough to cover the welding action completely. If a supporting Unionmelt dam is properly made, edges similar to those shown in Fig. 14 can be consistently produced.

There are many excellent opportunities to use the Unionmelt Process for depositing overlaid surfaces. Laboratory investigations have given an understanding of the problem of reducing rod dilution and producing deposits of required chemical analysis and hardness. The operating techniques for performing this work are now well established. The principles discussed herein make this method of depositing overlaid surfaces suitable to production, and it is felt that industry will find many opportunities for using this process.

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In order to conserve paper, the new 1947 A.W.S. Membership Directory, now available, will be sent only to those requesting a copy. There is no charge to members of the SOCIETY. Address request to: AMERICAN WELDING SOCIETY, 33 West 39th St., New York 18, N. Y.

Oxygen Cutting of Steel at Elevated Temperatures*

By J. F. Kiernan and J. S. Sohn†

Introduction

WAR-TIME demands for increased production in the steel industry accelerated the development of processes for oxygen-cutting steels at rolling-mill temperatures (1700–2000° F.). The success achieved in instances where the process was applied, firmly established its value in modern steel production and fabrication methods.

Several general statements and records of hot-cutting applications appear in the literature.[1,2,3] These are insufficient in number as well as detail to serve as a basis of fundamental standards and relationships such as exist for cold cutting operations. This paper is an attempt to fill the existing void and also contains useful data which have been derived from over 3000 controlled cutting tests. Included are the results of the studies of various operating factors affecting the efficiency of the hot-cutting process.

Exploratory work has revealed that oxygen-cutting operations at elevated temperatures are governed by the same general principles and are accomplished with a similar degree of dimensional accuracy and quality control associated with cold-cutting. Although the hot-cutting process embodies all the outstanding features inherent in oxygen-cutting applications, its value to industry is further enhanced by virtue of these salient points: increased production is achieved through faster cutting speeds; integration of the process in the roll-line maintains undisturbed continuity in the rolling-mill cycle; the flexible, mechanized cutting-oxygen apparatus is an efficient replacement for massive, fixed-position equipment such as shears, saws, slicers, etc.; multiple handling, machining, and reheating operations on huge, bulky masses of metal are eliminated. This latter point is particularly important in the case of high carbon and alloy steels that normally require preheating prior to cutting for metallurgical reasons.

General Considerations

For high speed cutting at elevated temperature the gas flow rates are considerably greater than are normally used during cold cutting of equivalent thicknesses and for this reason it is essential that provisions be made for supplying uniform and adequate volumes of oxygen and fuel gas. The capacity of the system should be of such magnitude that momentary peak loads created at other points of operation will not disturb the cutting oxygen supply for the hot cutting process to any appreciable degree. Line pressures (particularly for cutting oxygen) should be maintained high enough to guarantee constant torch entry pressures. The torch should be selected on the basis of capacity and construction with particular emphasis directed to the cutting oxygen element which should employ a voluminous passage in which all restrictions and turbulence creating foci are eliminated or reduced to a minimum. Operating pressures should be measured at torch entry. Where multiple torch operation is utilized, separate regulators of sufficient capacity should be employed for controlling the gas supply to individual torches.

Hose sizes should be such that large pressure drops between the point of regulation and torch entry are eliminated. Wherever possible the use of a single larger diameter hose is preferred over the employment of several of smaller size. Water cooling of all apparatus (including tips) directly exposed to high temperatures is essential to the stability and service life of the equipment. Suitable protective shielding should be provided for personnel and apparatus directly or remotely exposed to the heat and flying slag.

Test Methods

The general test procedure employed in the investigation involved maintaining all factors constant except the variable under investigation, thereby noting its effect upon the speed of cutting. All tests were conducted with preheating flames adjusted to neutral unless specifically noted otherwise. Acetylene was used for the fuel gas throughout the investigation.

Acetylene and preheat and cutting oxygen flows for the tips used were determined at their operating pressures by calibration with standard rotameters.

Working temperatures above 1400° F. were measured with an optical pyrometer; below 1400° F. tempil-stiks were used. Specimens of greater thickness than 5 in. were heated in a semi-muffle type oil-fired furnace. Smaller thicknesses were heated in a direct type gas-fired furnace. Soaking periods for test pieces were of such duration as to establish temperature uniformity throughout the specimen. The dimensions of the work were checked before inserting in the furnace.

Cutting speed determinations were obtained by measuring the distance traversed during a definite time interval. An electrically controlled timing device, mechanically coordinated with the torch travel, was used whenever small variations in speed were measured.

Materials and Analysis

Table 1 contains a list of the materials used during the experimental studies.

* Presented at Twenty-Seventh Annual Meeting, A. W. S., Atlantic City, N. J., week of November 17, 1946.

† Air Reduction Sales Co., Inc., New York.

Table 1

Thickness, In.	Length of Cut, In.	Composition
1	4	SAE 1040
$1^1/_2$	4	SAE 1020
$2^1/_2$	4	SAE 1020
$2^1/_2$	4	0.75 C
$2^1/_2$	4	1.32 C
4	6	SAE 1020
5	7	SAE 1020
6	6	SAE 1020
8	8	SAE 1020
12	8	SAE 1020

Table 2 indicates chemical analysis of the steels used for the carbon content—temperature studies:

Table 2

	0.20 C Steel	0.75 C Steel	1.32 C Steel
Carbon	0.20–0.21	0.75	1.323
Manganese	0.44	0.88	0.23
Phosphorous	0.019	0.014–0.026	0.012
Silicon	0.20	0.14 –0.15	0.10
Sulphur	0.027	0.030–0.035	0.021
Others	....	.....	0.21

Cutting Oxygen–Speed–Thickness Relationship

General standards for the quality of a cut on cold material have been established. These are based on acceptability and requirements of service. Quality cuts can be produced on steels at elevated temperatures at faster cutting speeds than on cold material. The kerf finish and dimensional tolerances are equivalent to those obtained for drop cuts (no uncut corners) on cold material of the same thickness (Fig. 1). In many applications quality is of negligible importance—speed is the primary factor. The increases in cutting-speed that can be obtained for cold cutting are comparatively small regardless of the allowed deterioration of quality. In this respect, cutting at elevated temperatures offers definite advantages. Large increases in speed may be obtained for high speed (severance) drop cuts where the finish and close tolerance factors are ignored.

The initial investigations were concerned with comparative tests between standard and divergent (high velocity) type[4] cutting oxygen orifices in the field of severance cutting. Faster cutting speeds, narrower kerfs and smaller deviations (variation from a plane surface parallel to the axis of the cutting oxygen stream, Fig. 2) in quality for equivalent oxygen consumptions were obtained with the divergent type tip, which is characterised by a high jet velocity with controlled expansion of the oxygen stream. These factors provide higher oxygen concentrations and more uniform reaction rates throughout the depth of the cut, particularly in the lower regions of the kerf where reduced drags are so essential to the production of high speed drop-cuts.

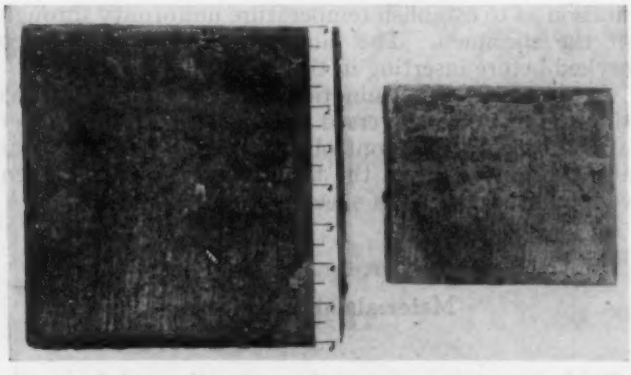


Fig. 1—8- and 5-In. Billets S.A.E. 1020 Cut at 1800° F. Average Speed 14 In. per Min. and 22 In. per Min.

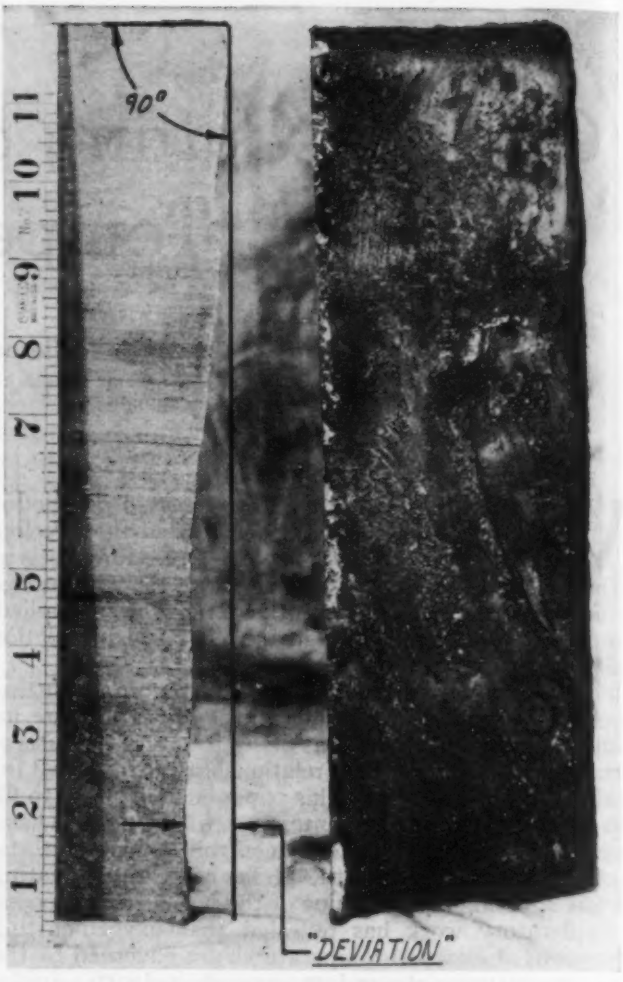


Fig. 2—12-In. Billet S.A.E. 1020 Cut at 1800° F. Average Speed 32 In. per Min. (22 Sec. Duration).

A comparison of the speeds attained with the divergent and standard drilled types of orifices for similar cutting-oxygen flows is shown on the 8-in. material curve of Fig. 3. It should be noted that the speeds obtained with the standard drilled type orifice approach the curve only when operated at much less than the normally utilized flows (6000-8000 cu. ft./hr. for the particular tips tested) also, the width of kerf and the deviation of quality were excessive in these instances.

The results of these comparative tests led to the utilization of divergent type cutting oxygen orifices operating at their optimum flow rate in all subsequent work. The information contained herein applies primarily to this type of cutting element. Further, wherever relationships between variables involving flow were established they are based on tests wherein increased flows were obtained by virtue of increased orifice sizes. Operating pressure may be varied through a considerable range but whenever increased flows were obtained by increasing the operating pressure the following reactions were noted: for any given tip, a maximum speed was attained at an optimum flow rate; any flow in excess of the optimum resulted in a definite loss of speed. The optimum flow rates for divergent type tips were obtained at pressures

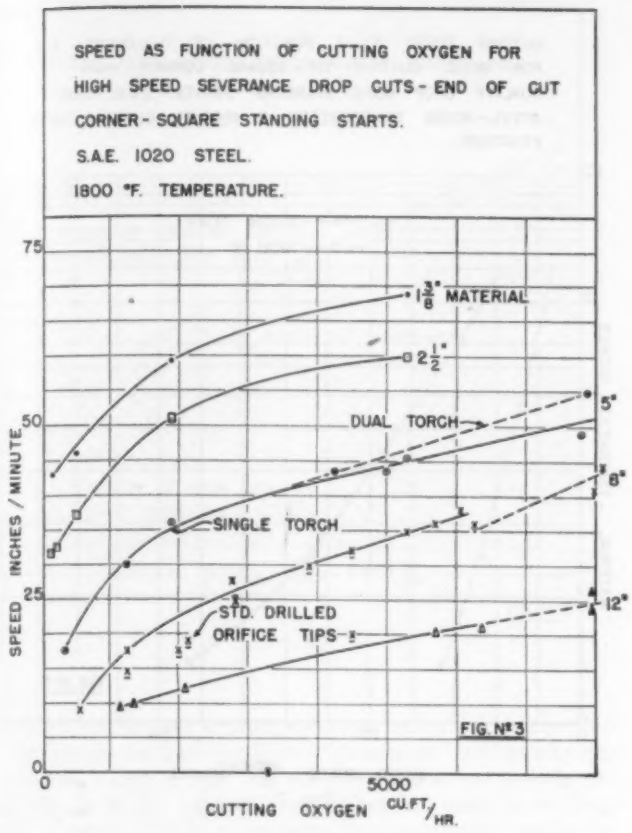


Fig. 3

above those recommended for cold cutting the same thickness of material.

As previously mentioned, the initial exploratory work disclosed the existence of two distinct types of cutting, quality (Fig. 4) and severance (Fig. 2) drop cuts. Independent investigations were made for each type of cut after which results were analyzed and correlated.

Figure 3 illustrates the speed-cutting oxygen flow relationship for severance drop cuts on $1^3/_8$, $2^1/_2$, 5, 8 and 12 in. thicknesses of SAE 1020 steel at 1800° F. Each curve consists essentially of two parts with the exception of

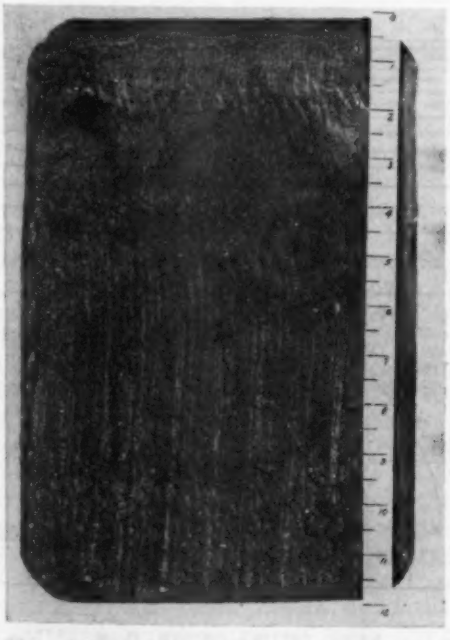


Fig. 4—12-In. Billet S.A.E. 1020 Cut at 1800° F. Speed 10 In. per Min.

that for the 12-in. material for which low flow rates (less than 1000 CFH) were not studied. The initial portion embodies the flow region below 2000 cu. ft. per hr. whereas the remaining portion is concerned with the region of greater flows. The effect of increasing the flow at a rate of 100 cu. ft. per hr. within the initial region is to increase the speed approximately 1 in. per minute. In the secondary region the speed increase changes to an increment approximately $^1/_8$ in. per minute for each increase in flow of 100 cu. ft. per hr. This relationship holds true up to approximately 8000 cu. ft. per hr. which was the upper limit of flow investigated.

Figure 5 indicates the speed-cutting oxygen flow relationships for all thicknesses of material up to 12 in. and is a complementary presentation to Fig. 3.

For the production of quality drop cuts the effect of varying the cutting oxygen flow rate on the speed is illus-

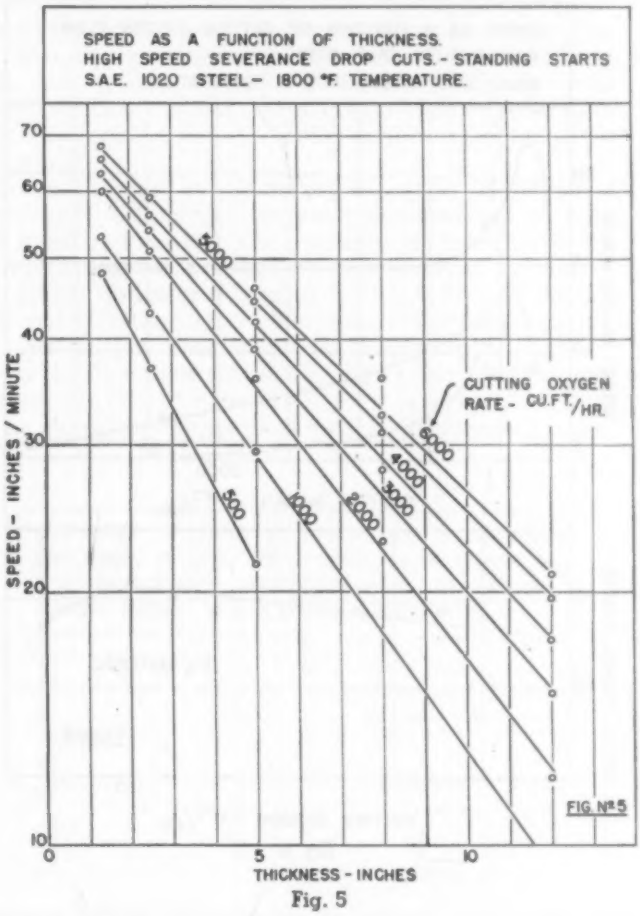


Fig. 5

trated on Fig. 6. It will be noted that for the range of oxygen flows studied the initial effect on the speed was to rise to a maximum with increasing oxygen flow. Further increases in the flow resulted in decreasing the speed. Particular attention is directed to the sharp decrease in speed at the 190 cu. ft. per hr. flow on the $2^1/_2$-in. curve. The increased flow was obtained by increasing the pressure beyond that at which the optimum flow rate of the tip was obtained.

Figure 7 shows a comparison between the recommended cutting speeds for quality cuts on cold material and those determined at a temperature of 1800° F. for various thicknesses of SAE 1020 steel. The ratio of hot-cutting to cold cutting speed varies approximately as follows: 3:1 for material up to $2^1/_2$ in. thickness, $2^3/_4$:1 for material from 3 to 7 in., $2^1/_2$:1 for material from 8 to 12-in. thickness. Figure 8 indicates the relationship be-

tween thickness and cutting-oxygen flow for the hot cutting speeds shown on Fig. 7.

The final phase correlating the severance and quality cutting is best portrayed by the schematic chart, Fig. 9, which shows the speed-cutting oxygen flow relationship for the production of drop cuts at elevated temperature for a given thickness of material. During the investigation it was noted that when cutting a particular thickness of steel at 1800° F. certain tips operating at their optimum cutting oxygen flow rates, as shown on Fig. 9 Points A and B, were only capable of producing drop cuts of high quality. Any increase in speed over that indicated resulted in the loss of the ability to obtain a drop cut, while still retaining the quality of the cut. Further, it was noted that other tips of higher optimum flow rates (Points C-D-E) were capable of producing drop cuts of quality at definite speeds, and severance drop cuts of less

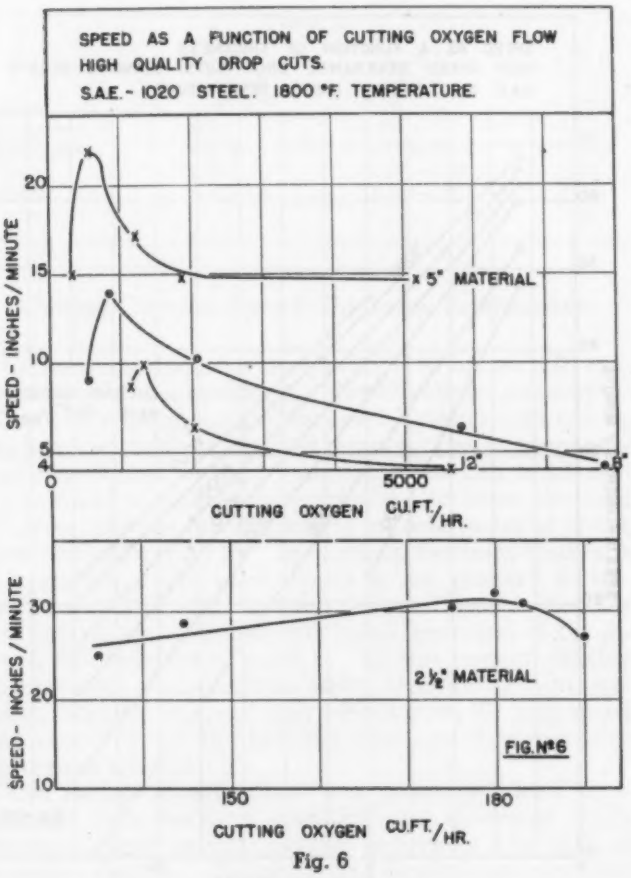
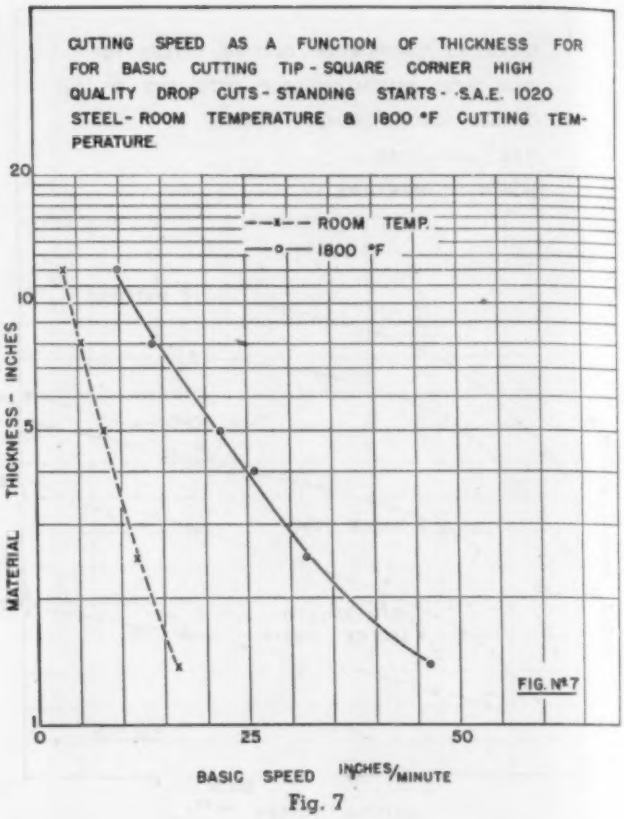


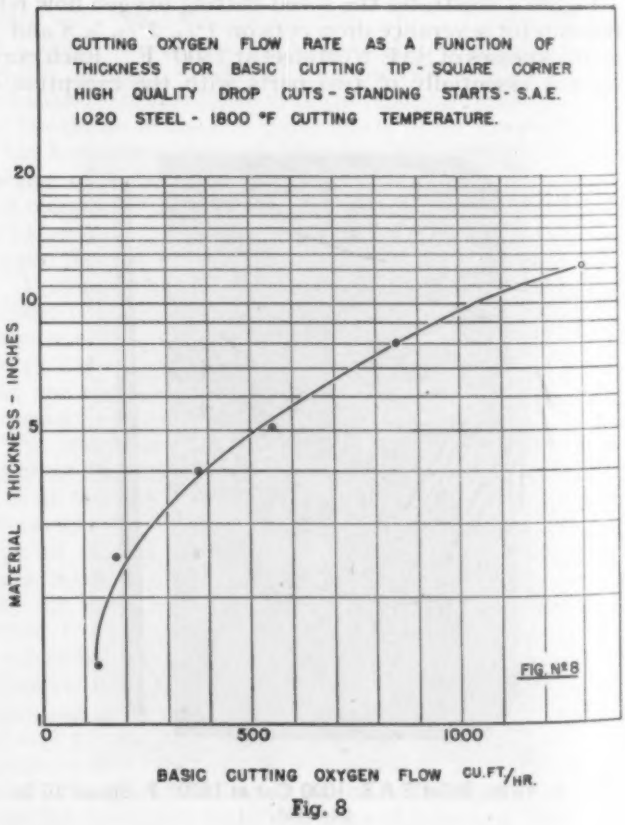
Fig. 6

than maximum quality at considerably higher speeds. These findings indicated the existence of a maximum speed for quality cuts as well as a minimum severance drop cut speed with the probability of a definite relationship between them.

The unexplored region between the flow rates *B* and *C* was investigated in detail in order to verify the above assumptions. A series of tests were made utilizing divergent type tips in which increasing flow rates were achieved by utilizing larger orifice sizes. The results of this phase of the study are indicated by the dual curves between the flow region B-C, Fig. 9. Thus, for a given thickness of steel there is a definite cutting oxygen flow (Point F) at which quality drop cuts may be made at maximum speed. It also represents the limiting (minimum) flow rate above which speed increases may be attained at the expense of quality deterioration. This flow has been designated as "basic oxygen" and represents the rate at which greatest consistency of operation


CUTTING SPEED AS A FUNCTION OF THICKNESS FOR FOR BASIC CUTTING TIP - SQUARE CORNER HIGH QUALITY DROP CUTS - STANDING STARTS - S.A.E. 1020 STEEL - ROOM TEMPERATURE & 1800 °F CUTTING TEMPERATURE.
ROOM TEMP.
1800 °F
MATERIAL THICKNESS - INCHES
BASIC SPEED INCHES/MINUTE
FIG. Nº 7
Fig. 7

and economy is effected. It will be noted that cutting tips delivering amounts of oxygen equal to or less than the "basic oxygen" rate required for a given thickness of steel are capable of producing high quality drop cuts only, whereas, a tip delivering cutting oxygen at a rate greater than the "basic" may be operated to produce quality as well as severance drop cuts. Curve ABFE


CUTTING OXYGEN FLOW RATE AS A FUNCTION OF THICKNESS FOR BASIC CUTTING TIP - SQUARE CORNER HIGH QUALITY DROP CUTS - STANDING STARTS - S.A.E. 1020 STEEL - 1800 °F CUTTING TEMPERATURE.
MATERIAL THICKNESS - INCHES
BASIC CUTTING OXYGEN FLOW CU.FT./HR.
FIG. Nº 8
Fig. 8

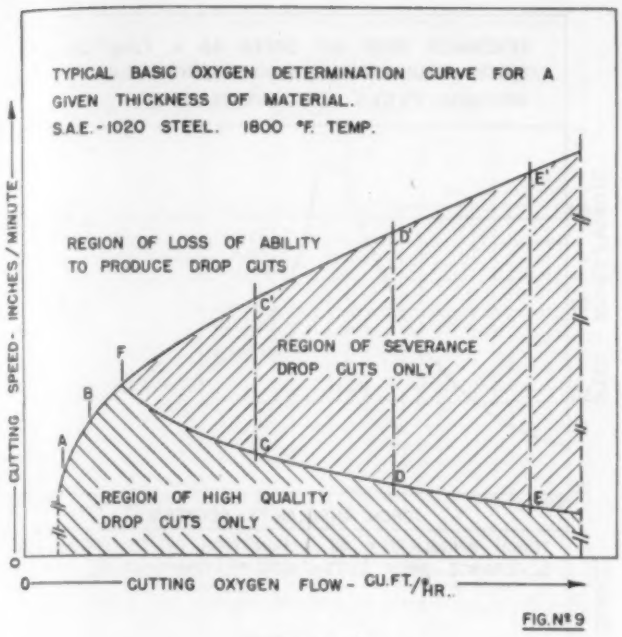


Fig. 9

Fig. 9, shows the maximum speeds which can be achieved for the production of quality drop cuts at various oxygen flow-rates. Curve FE′ shows the maximum speeds attainable at given oxygen flow rates for severance drop cuts. Curve ABFE′ represents the maximum speeds for drop cuts at given oxygen flows irrespective of the quality of the cut.

It should be noted that, for quality cutting (Fig. 9—Curve ABFE) the speed increases with higher oxygen flows to a definite maximum value at "F", the point of "basic oxygen" flow. Further increases in oxygen flow result in a decrease in cutting speed caused by a widening of the kerf. Note also that this curve ABFE is similar to the quality cutting curves of Fig. 6 which show a magnified version of the point F on Fig. 9. The curve for severance cutting at less than maximum quality (curve FE′) has its origin at "F" the "basic oxygen" flow point. The speed of cutting increases with higher oxygen flow rates and does not reach a maximum within the flow range investigated, as shown by the similar severance curves of Fig. 3. In fact, curves such as AFE′ and AFE of Fig. 9 may be constructed for a given thickness by the super-position of curves from Figs. 3 and 6.

Investigation of various thicknesses of steel to determine the cutting speed-oxygen flow relationship using the "basic oxygen" concept as the guiding principle of the experimental work resulted in a family of dual curves, all similar to Fig. 9 and showing that the "basic oxygen" flow increases with thickness as shown by Fig. 8; also, for any given thickness, there is an increase in the "basic flow" rate of approximately 5% for a carbon content increase from 0.20% to 0.75% in plain carbon steels at temperatures at and above 1400° F.

The investigation of the "basic oxygen" concept established an experimental method which may be used as a standard procedure for evaluating the performance of any cutting tip and for determining the cutting speed oxygen flow relationship for any type or thickness of steel. The data and curves accumulated form the fundamental basis for the design of cutting tips and the prediction of cutting speeds, oxygen flows and quality obtainable.

To summarize, it has been demonstrated that when cutting at elevated temperatures all speed oxygen flow relationships are a function of the speed—"basic oxygen" relationship for any given thickness, all "basic oxygen"—thickness relationships may be expressed as a continuous function; all quality-speed relationships are a function of "basic oxygen" speeds.[5]

Auxiliary Cutting Oxygen

Dual-torch operation was initiated as a means of utilizing the cutting oxygen more effectively. The results obtained as plotted on Fig. 10 demonstrate that more efficient use of the cutting-oxygen can be achieved. Attention is directed to the faster cutting speed obtained with the dual jet wherein the combined oxygen flow of the two smaller jets is equivalent to that of a single larger jet. Equal effectiveness with respect to cutting speed for standing and running starts during severance cutting is readily shown by the curves. Further advantages were noted in that the dimensional deviation of the kerf during severance cutting at higher speeds than single tip operation was generally less than the maximum shown on Fig. 19; also quality cuts on 15-in. rounds revealed that less scale and beading formed on the kerf. Finally, dual torch operation was more consistant at higher speeds than with the single jet in so far as the continuity of the cut is concerned.

Several primary requisites are necessary to successful operation: the oxygen stream characteristics of both jets must be known. The auxiliary jet must be of the divergent type. The main jet may be either the standard drilled orifice or divergent type but best results are achieved with the latter. The ratio of the main to auxiliary jet oxygen flow should be approximately $2^1/_2$:1. When the flow through the auxiliary jet is less than prescribed, the effectiveness of the jet is practically nil in so far as increasing the speed of cutting is concerned. The

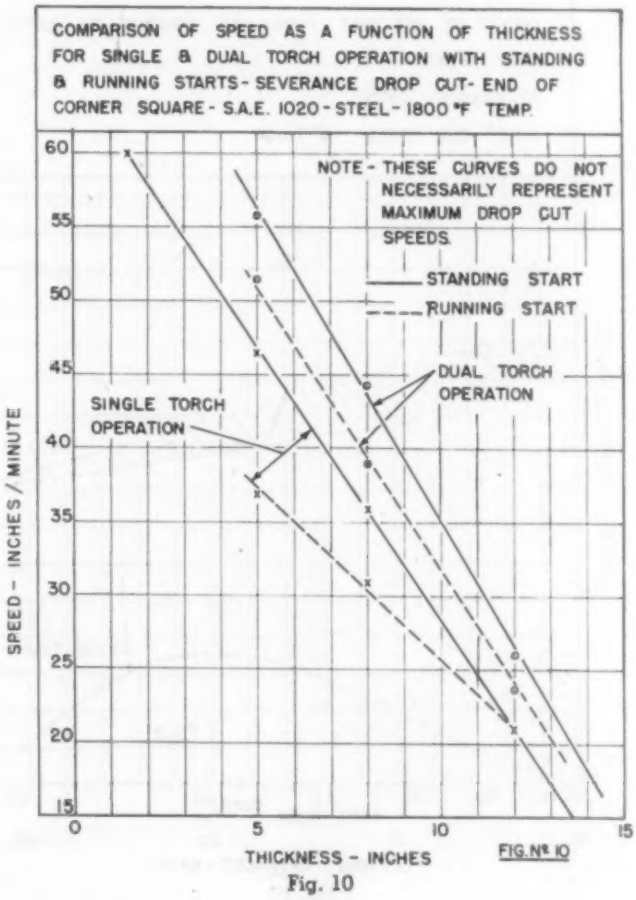


Fig. 10

main jet flow must be of such magnitude as to be capable of effecting complete depth penetration of the work when used alone.

Preheat Flames

The results of the effects of the preheating flames during the cutting studies are more or less of a general nature giving information regarding trends rather than specific data. The complex function of the preheating flames as well as the masking effects of other variables entering into the reaction make it difficult to isolate the influence exerted by the preheating flames.

A study of the effect of preheat upon the speed of severance cutting was made. The specimens were 4 in. thick—SAE 1020 steel at a working temperature of 1800° F. The method was to maintain all factors constant while observing the effect upon speed of varying the acetylene flow from the minimum (20 CFH) to the maximum (50 CFH) obtainable through the tip. The flames for the various volumes were adjusted to neutral. The results indicated on Fig. 11 show that the speed increases with decreasing cutting oxygen to acetylene ratios for the magnitude of flow range studied. It should be observed that a 100% increase in acetylene flow rate was required for a 20% speed increase. Also shown is a curve for the identical test on cold material where in a speed increase to a maximum followed by a decrease is noted for decreasing ratios.

Neutral flames were observed to react most favorably for high speed severance operations. Oxidizing flames were used and found to result in less stable burning qualities with no increase in cutting speed. Carburizing flames resulted in slower cutting speeds with greater kerf deviations than with neutral flames.

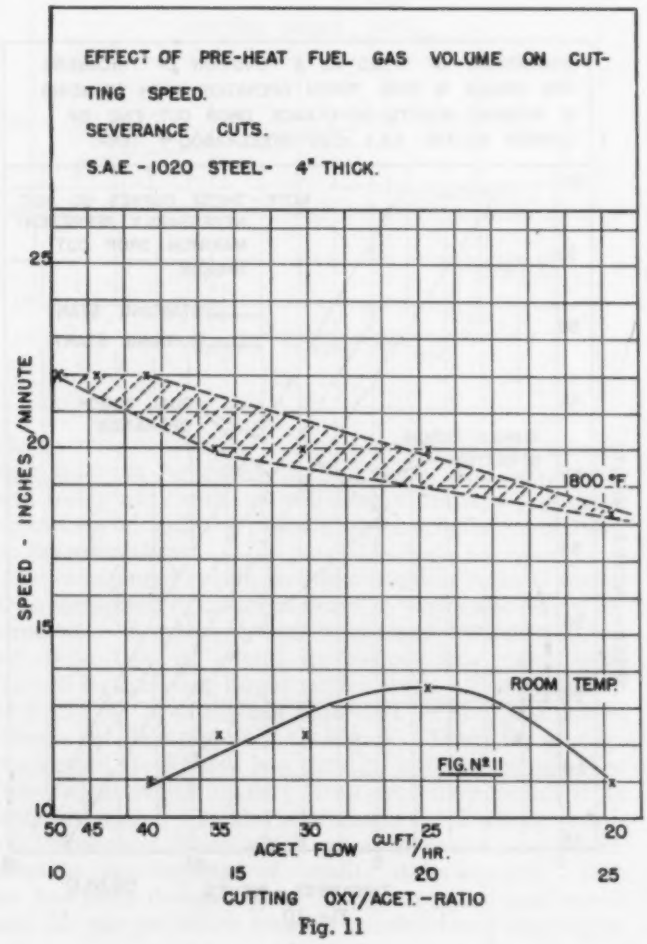


Fig. 11

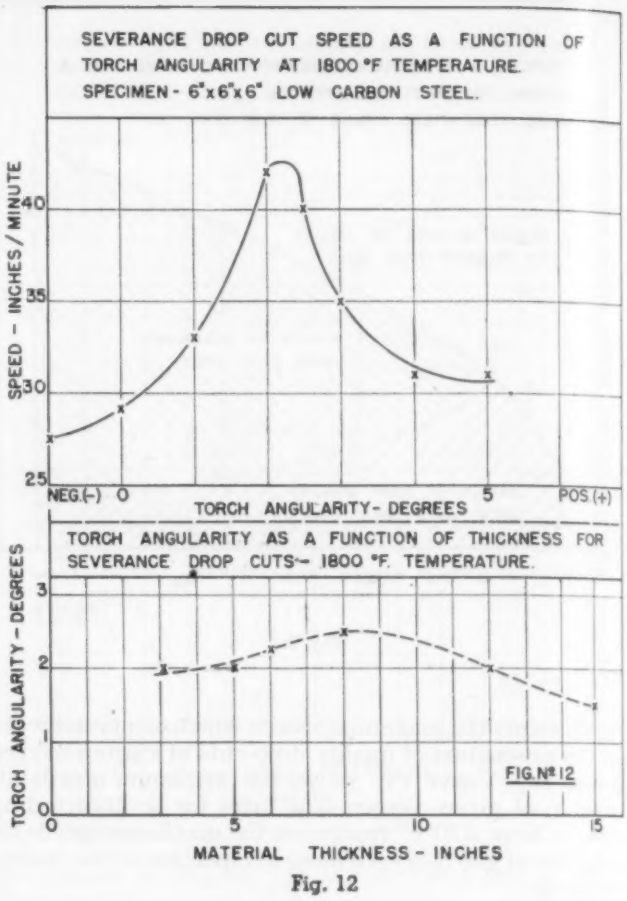


Fig. 12

For the variety of tips used during the investigation the acetylene flow covered a range of 20 to 758 cu. ft. per hr.

Best ratios of cutting oxygen to acetylene for quality cutting were 18:1 to 15:1, whereas for severance cutting the ratios were 25:1 to 20:1. Acetylene should not exceed approximately 300 cu. ft. per hr. inasmuch as the advantages accruing are far out of proportion to the increased cost of operation.

For operational stability during hot-cutting it is essential that uniformity of flame balance be established and maintained. Heavy preheat is necessary for high speed operation in that it reduces or elifninates the scale on the starting and upper faces of the work as well as markedly increasing the temperature of the work in region of the ignition zone. Faster standing and running starts are also possible.

Of utmost importance is the length of the flame envelope; the full body of which should extend well beyond the depth of the material being cut. This not only aids in conditioning the surface for rapid starts but also established a high heat concentration in the lower regions of the kerf where it is needed for the production of high speed drop cuts. Slag fluidity is maintained which considerably reduces the amount and tenacity of the scale formed in the kerf.

Preheating the cutting oxygen is necessary even when cutting at elevated temperatures. A flattened copper tube without attached preheating flames was used as the auxiliary jet in a dual tip cut. The tube was of such dimensions that it would pass within the kerf while its exit extended to within two inches of the bottom of the cut. In operation the cutting speed was reduced below that attainable with the main jet alone. The auxiliary oxygen failed to enter into the cutting reaction and chilled the slag, thus reducing its fluidity which increased the

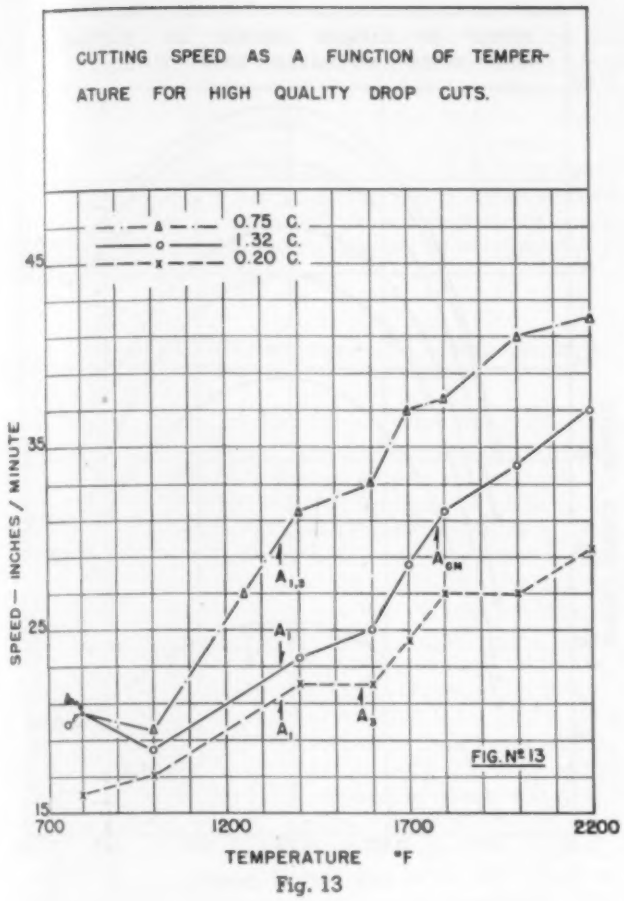


Fig. 13

drag to such an extent that the speed had to be sharply curtailed in order to prevent "shelving." (Failure of the oxygen stream to pierce the work with a subsequent eruption of molten steel and slag.)

It was noted for large acetylene flows that when the angularity of the orifice drillings was of such magnitude that the flames impinged too markedly on the oxygen stream, the result was the creation of a distorted and turbulent stream which reduced the speed of cutting. Similar results were also noted when the pre-heat orifices were too closely packed, that is, the base circle of the holes was too small with respect to the oxygen stream diameter. The most effective positioning of the preheat flames for the particular method of cutting employed was observed to be that wherein the holes were equally spaced around and concentrically located with respect to the oxygen stream.

It may be well to point out that although the speed increased with acetylene input, for values above approximately 300 cu. ft. per hr., the input was far out of proportion to the corresponding speed increment realized. In view of the poor economy associated with obtaining speed increases by employing higher rates of acetylene flow than the aforementioned, it is suggested that this method be utilized to increase speed only as a last resort.

An attempt to increase the speed of severance cutting by having a preheating element leading the cutting jet was unsuccessful. To be most economical and effective the element should be located in close proximity to the jet. In such a position some of the flames are reflected from the work and tend to distort the oxygen stream. The increased drag and resultant loss of cutting speed more than offsets the advantages that accrue from the descaling and localized heating at the reaction front on the upper edge of the work. More significant results for increasing the speed of running start cuts were obtained by applying auxiliary heating to the vertical starting face. The effectiveness of this method decreases with increasing thickness because the reduced speeds of cutting rather than the speed of starting is the limiting factor.

With dual torch operation, the auxiliary torch preheat is directed against the vertical starting face. The increased cutting speed as well as the lower speed differential between running and standing starts for single and dual torch operation as indicated on Fig. 10 is partially attributable to the beneficial effect of the auxiliary torch heating.

Torch Angularity and Operating Height

The angular adjustment is designated as positive (+) when the torch is inclined in the direction of travel, and negative (−) when it leans backward with respect to torch travel. Initial studies were concerned with the determination of a single, fixed-angle adjustment of the torch. The factors primarily involved were the ease of starting and drop-cut ability with respect to speed of cutting for various thicknesses. Angularity effects were determined for 5, 6, 8 and 12-in. material with the variable range extending from +5° to −2°.

An exhaustive study was made on 6-in. material. Geometrically precise specimens were prepared and carefully mounted in order to eliminate possible sources of error. The results of this study are plotted on Fig. 12. Also appearing is a curve showing the relationship of the angularity with respect to the material thickness. It may be of interest to note that angularity tests on cold 6-in. material were conducted under the same operating conditions as the 1800° F. studies. Although the change in speed was not as pronounced as on the hot material, the results followed the same general pattern with respect

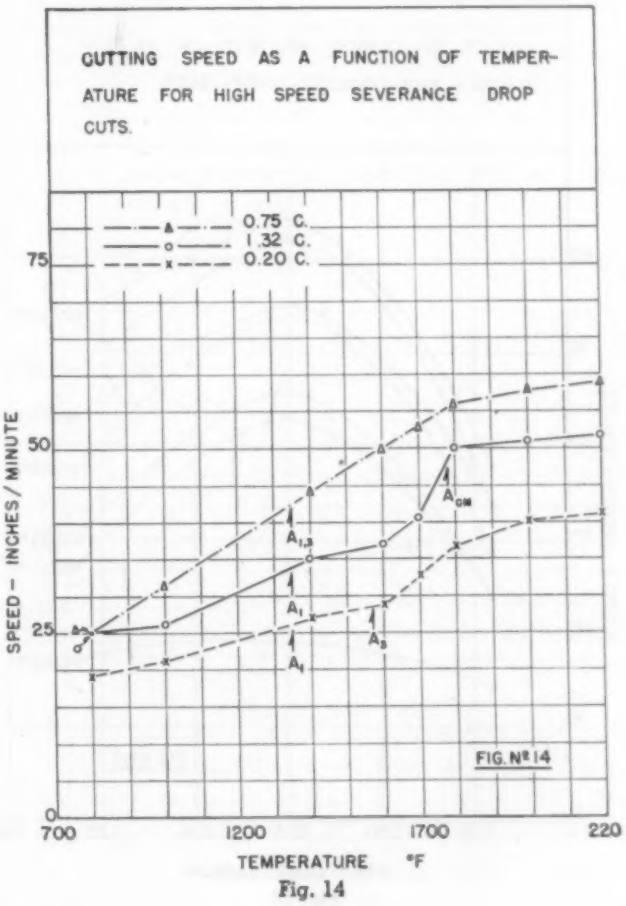


Fig. 14

to uncut corners and speed. The maximum drop cut speed occurring at $+2°$ angularity.

The effect of torch angularity is most pronounced on severance cutting. Experimental work has disclosed that a reduction of the angularity from $+2^1/_2°$ to a lower limit of $+1^1/_2°$ has no effect, provided the speed of cutting is not in excess of 20 in. per min. This condition applies to quality as well as severance cuts where in the primary limiting factor controlling the speed is the thickness of the hot material being cut. Angularity settings in the range of $+1^1/_2°$ to $0°$ resulted in less stable operation with regard to continuity of the cut and repetitive performance. Lower starting and cutting speeds were also characteristic of the lower angularity range. Negative angles were conducive to poor operation. Besides having decided detrimental effects on the speed, the fouling of the tip and "shelving" in the cut at the start was most pronounced.

Successful test cuts with dual-tip operation prompted a study of angularity effect. The relative position of the auxiliary jet to main jet is critical. Large deviations from the maximum attainable cutting speed are the result of small variations from the optimum adjustment of the auxiliary jet.

The main basis for the auxiliary jet location and angularity is the intersection of the jet center-lines at the lower edge of the material being cut. When the auxiliary jet impinges too markedly on the main stream within the kerf, the result is the creation of a distorted, turbulent main stream that gouges and widens the kerf with a subsequent loss of cutting efficiency. The maximum speed under this condition will be less than that obtainable with the main jet alone. When the auxiliary jet fails to intersect the main stream at the bottom of the work the jet will pass through the kerf without entering into the cutting reaction. It also fails to pick up the cut when it contacts the uncut corner left by the main jet.

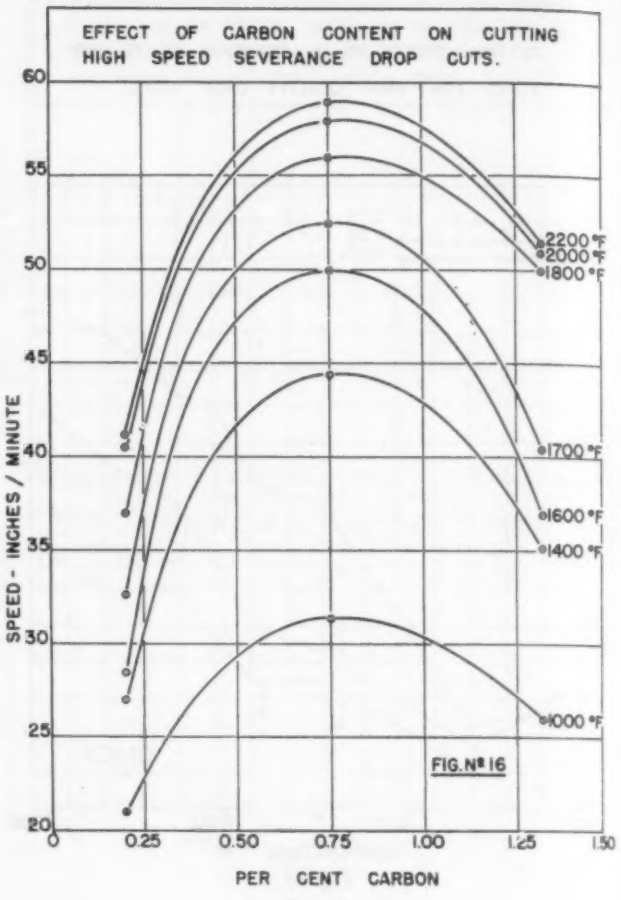


Fig. 16

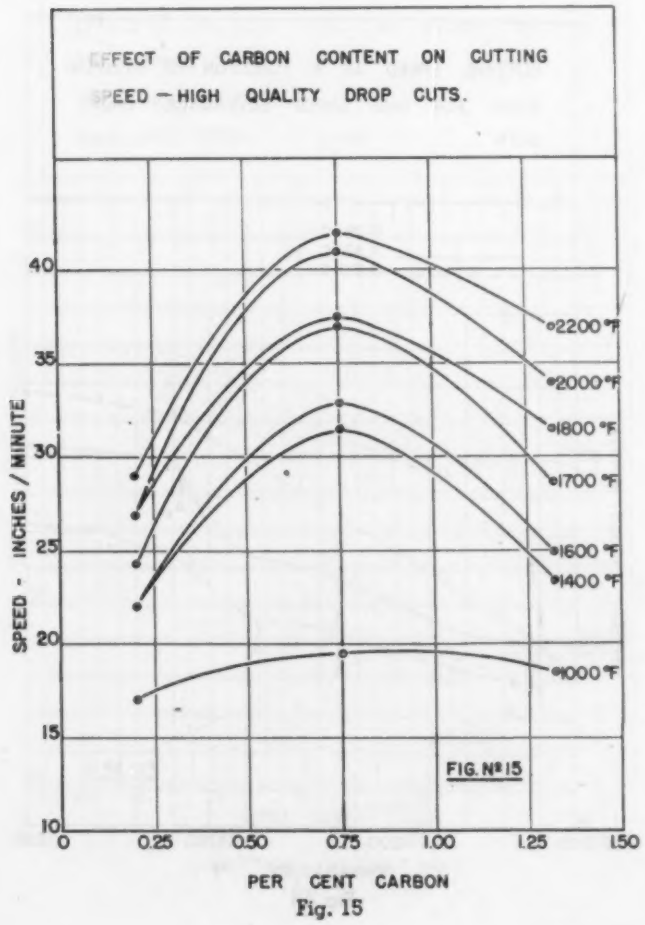


Fig. 15

Extensive experimental determinations showed that a minimum operating height of $1^1/_4$ in. from the tip face to work gave the best results in so far as constancy of operation was concerned. The height can be increased to 2 in. without appreciably affecting the speed and quality of the cut. During severance cutting some slag is periodically ejected vertically upward with sufficient velocity as to momentarily disturb the cutting oxygen stream and preheating flames which may result in the loss of the cut. A tip at a lower operating height than prescribed will be more exposed to this condition. Fouling of the exit edge and divergent section of the tip is also minimized at the greater operating height as is melt down of the upper edge of the kerf.

Starting of Cut

Standing starts, wherein the tip is stationary until the cut is started, may be made by applying the cutting oxygen immediately after the tip has been positioned. Ample preheating of the starting edge is achieved in the two or three seconds required to correctly locate the tip. This time is in direct contrast to the extended preheating period required for starting cuts on cold material. In order to prevent fouling of the tip and to reduce "shelving" tendencies during standing starts, care should be exercised in locating the tip so that the overlap of the oxygen stream on the starting surface does not exceed one-quarter the diameter of the jet.

Running starts can be made without difficulty at speeds approximately 10% less than those attained with standing starts for materials up to and including 8-in.

thickness. The running start can be made on thicker materials at approximately the same speed as standing starts. The reduced speed of operation, which is largely a function of the size factor, is responsible for the coincidence of the running and standing start speeds.

The shape factor limitations such as is encountered in starting cuts on cold round material is eliminated on hot material. Running as well as standing starts on rounds can be made with the same ease as on rectangular material.

Effect of Temperature and Carbon Content

Early in the experimental work involving the severing of 8 × 8-in. low-carbon steel, it became apparent that the working temperature was an important variable for the cutting speed range being investigated (35 to 45 in. per min.). "Shelving" occurred most frequently at temperatures below 1700° F. Variations in repetitive performances were encountered which could only be due to temperature changes. The relation of temperature to the speed of cutting was isolated by a study on $2^1/_2$-in. material with all factors maintained constant while the temperature was varied and the effect on speed noted.

The results, as indicated on Figs. 13 and 14, show the effect of temperature on speed for quality as well as severance cuts. The abrupt changes of slope occurring within each curve were verified by over 400 test runs. The appearance of the curves immediately implies a connection with the thermal critical points of steel. For convenience, these points have been indicated on the curves. The coincidence is readily apparent. The initial, negative slopes indicated for higher carbon steels on the quality curves of Fig. 13 have been rechecked many times. The initial portions of the severance curves of Fig. 14 show positive slopes. It is believed that the increased speed of cutting allows insufficient time for the retardation to occur. It was found that constant repetitive performance for a given set of operating conditions was obtained only when the pieces being cut had the same metallurgical history. The marked similarity between the quality and severance curves is a clear indication that temperature effects are pronounced regardless of the type of cutting employed.

The effects of carbon content upon the speed of cutting for quality and severance cuts was determined in conjunction with the studies pertaining to temperature and is indicated on Figs. 13 and 14. The isothermal curves (Figs. 15 and 16) indicate the degree and manner that carbon content affects the speed of cutting at elevated temperatures. They also serve to emphasize the importance of carbon upon the speed of cutting. It will be noted that at 0.75% carbon, where the effect upon speed is greatest, the increase due to the carbon content is approximately the same order of magnitude as the speed increase due to temperature alone.

Metallurgical Effects

The metallurgical problems and special techniques involved when cold cutting steels of medium and high carbon content are eliminated when cutting at elevated temperatures.

A series of oxygen cut specimens were prepared from the same original stock of plain carbon steel of 0.41% carbon content. The operating conditions were maintained constant except that the speed and temperature were varied as indicated.

Specimen	Speed, In./Min.	Temperature, °F.
A—#1, 2 and 3	18	75
B—#1, 2 and 3	18	1800
C—#1, 2 and 3	30	1800

The results of the investigation showed that the cuts made at elevated temperature yielded a cut surface free of carbon enrichment and with no appreciable hardness gradient (See Fig. 17) as compared with cuts in cold specimens which show carbon enrichment, Fig. 18*A*, of the cut surfaces and increased hardnesses on the edge. The hot cut specimens Fig. 18*B* and 18*C*, showed a slight (0.004 in.) decarburization at the cut edge which was heaviest under the preheat flames and gradually decreased in thickness toward the bottom of the cut. Grain growth along the cut edge of the hot cut specimens was inappreciable.

Forging slugs (0.60–0.70% carbon) were oxygen cut at elevated temperature (1800° F.). The severe service to which the finished product of these slugs is subjected requires an absolutely sound, normal structure with no evidence of thermal checking or other undesirable features. An exhaustive metallurgical examination revealed that the slugs could be satisfactorily oxygen cut with no adverse effects.

Surface Scale and Discontinuities

It was observed that the most pronounced effect of surface scale is upon the speed rather than on the continuity of the cutting operation for the carbon steels investigated. For severance drop cuts a maximum initial drag exists for each thickness of material, which rapidly decreases to a zero drag when the full depth kerf is established on the starting face. Closely adhering surface and sub-surface scale deposits on the vertical starting face of the cut, increases the time required to establish the full depth kerf. Inasmuch as the horizontal travel of the torch is started when the cutting oxygen is turned on, the time of the vertical reaction is a major factor in determin-

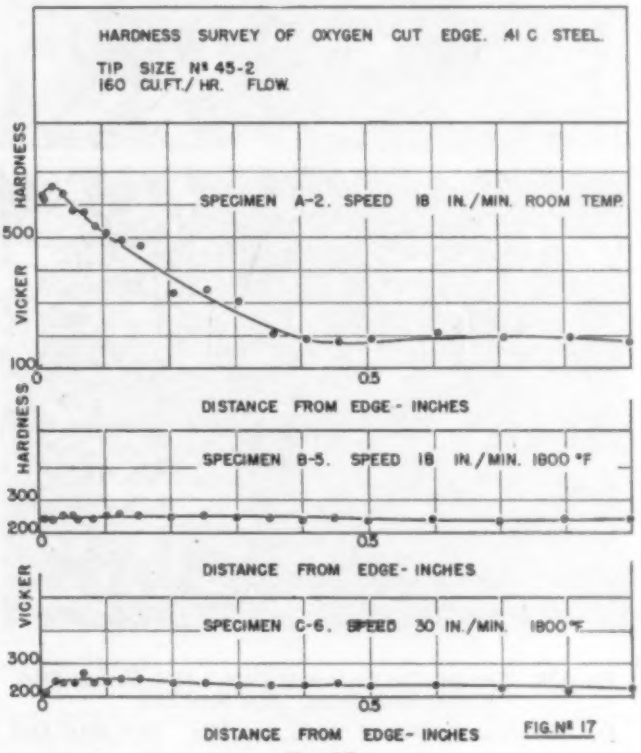
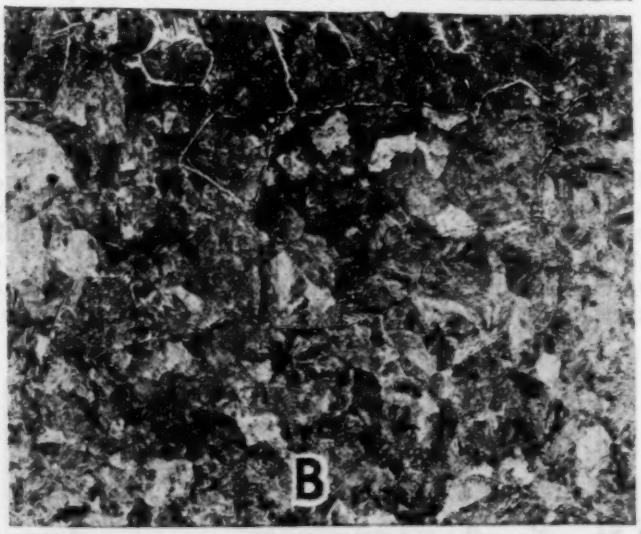


Fig. 17



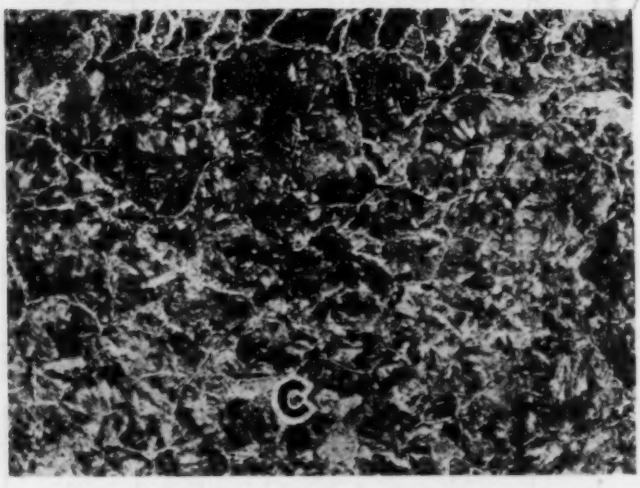


Fig. 18A—Oxygen Cut Surface of Plain 0.41% Carbon Steel, Cut at Room Temp. 75× Nital Etch

Fig. 18B—Cut at 1800° F. 18 In. per Min. 75× Nital Etch

Fig. 18C—Cut at 1800° F. 30 In. per Min. 75× Nital Etch

ing the magnitude of the initial drag which limits the speed of cutting. When the maximum initial drag is exceeded slightly, the starting corner remains uncut. Any further increase in drag results in "shelving." Tightly adhering scale deposits in excess of $^1/_{32}$ in. on the vertical starting face will lower the running start speeds to such an extent that auxiliary preheating of the face will be required. Quality cuts are produced at considerably lower operating speeds, therefore, the effect of the scale on the starting face is negligible.

For the magnitude of preheat employed in the cutting tips used during the experimental work, little difficulty was encountered with respect to the continuity of cutting for scale deposits up to approximately $^1/_{16}$-in. thickness on the upper surface of the work. In the event of scale deposits moderately exceeding $^1/_{16}$ in., the material can be cut but only at the expense of a reduction in speed.

The effects of internal and external discontinuities on severance cutting was such that a $^1/_8$-in. wide crack perpendicular to the plane of the cut offered no impediment to the continuity of the cut nor was any tendency of the crack to promote "shelving" noted. Cracks are readily discernible in the cut surface and indicate their presence in the form of bright lines. Similar favorable reactions were observed when the restrictions were in the form of a $^5/_8$-in. square keyway (with and without a key) and a 2-in. diameter hole in $10^1/_2$ and 12-in. diameter rounds.

Quality of Cut

Kerf finish, dimensional tolerances, melt down of top corner, scale on surface and amount of slag and bead remaining are the factors used to judge quality. Deviation (Fig. 2) which occurs only when cutting in the severance drop cut region of Fig. 9, is the chief characteristic used to identify and define severance cutting. The deviation at the lower severance speeds for a particular material thickness becomes apparent as a uniform concavity that extends from the upper to lower edges of the cut. As the speed of cutting increases the concavity changes into a distinct form which is characterized by the presence of a shoulder that extends horizontally across the face of the cut.

The location of the shoulder with respect to the distance from the upper edge is a function of the speed of cutting and oxygen consumption. The distance decreases with increasing speed and with increasing oxygen input. Thickness of material being cut apparently has no affect on the shoulder location. The sharpness and depth of the shoulder increases with increasing speed, oxygen input, and material thickness. The portion of the kerf above the shoulder is usually straight and of good quality whereas below the shoulder the kerf widens and may be gouged or fluted.

During the progress of a severance cut of the above mentioned type, a characteristic readily observable zone of intense reaction or ignition appears slightly below the shoulder. Since the location of the shoulder moves downward with decreasing speed, one can be found for which the zone occurs just below the bottom edge of the work. This speed will be the fastest speed at which a quality cut can be produced for the given operating conditions.

The maximum observed deviations of the severance kerf from a quality cut surface for various cutting speeds and thicknesses of material are shown on Fig. 19.

Additional factors affecting quality are scale and beading. The magnitude and tenacity of these are a function of temperature and carbon content. At working temperatures below 1400° F. the formations were easily removable, above 1400° F. the tenacity of the scale and

bead increased with increasing temperature. An exception to this condition was that of the higher carbon steels where a definite decrease in the tenacity of the scale for temperatures above 1400° F. was noted although the bead condition did not change. The tenacity of the bead at the higher temperatures is apparently due to a form of rewelding of the melt at the bottom of the kerf.

During the over-all hot-cutting operations, it was observed that for severance cutting with inherent high rates of oxygen input and consequently high operating speeds, the degree and persistency of the scale and bead were greatest. It was further noted that the thickness of the material being cut did not exert any influence on these factors. For quality cutting the bead and scale tendencies were less for the same temperatures. For any given set of constant operating conditions during quality cutting, it was observed that by varying the speed a value could be obtained at which the scaling and beading could be reduced to a minimum. Unfortunately this speed did not necessarily coincide with the maximum drop cut speed.

Melt-down of the upper edge was more pronounced on severance-cutting wherein large volumes of preheating gases and cutting oxygen are employed. Inasmuch as speed is the essential objective of the severance process, this factor becomes relatively unimportant. Quality cutting employs considerably lower preheat and cutting oxygen rates and the melt-down can be controlled to the same degree as in cold cutting. An added control feature on hot cutting which helps prevent melt-down of the upper edge is the greater torch operating height. This control can be exercised through a greater range than is possible to effect on cold cuts. Referring to Fig. 1, the 8-in. material cut shows considerable melt-down caused by excessive preheat; the 5-in. material cut shows the effect of insufficient operating height. Figure 4 indicates clearly the degree to which the melt-down may be controlled, without loss of cutting speed, by proper adjustment of preheating flames and operating height.

Kerf Width

The accompanying table shows a comparison between the kerf widths obtained for hot and cold quality cutting for various sizes of material utilizing the "basic oxygen" flow-rate tips. It will be noted that no increase in width results for quality cutting at elevated temperatures. Further, the width of the straight portion of the kerf above the shoulder during severance cutting is equivalent to that obtained during quality cutting for the same size orifice. As previously noted for this type of cut the deviation of the kerf as shown on Fig. 19 occurs below the shoulder.

Standard drilled orifice type of tips produced wider kerfs than cold cutting operation for both severance and quality cuts.

Table 3

Thickness	Width of Kerf, In. 1800° F.	75° F.
1 1/2	5/32	5/32
2	5/32	7/64
3	1/8	1/8
5	1/8	9/64
8	5/32	11/64
12	1/4	17/64

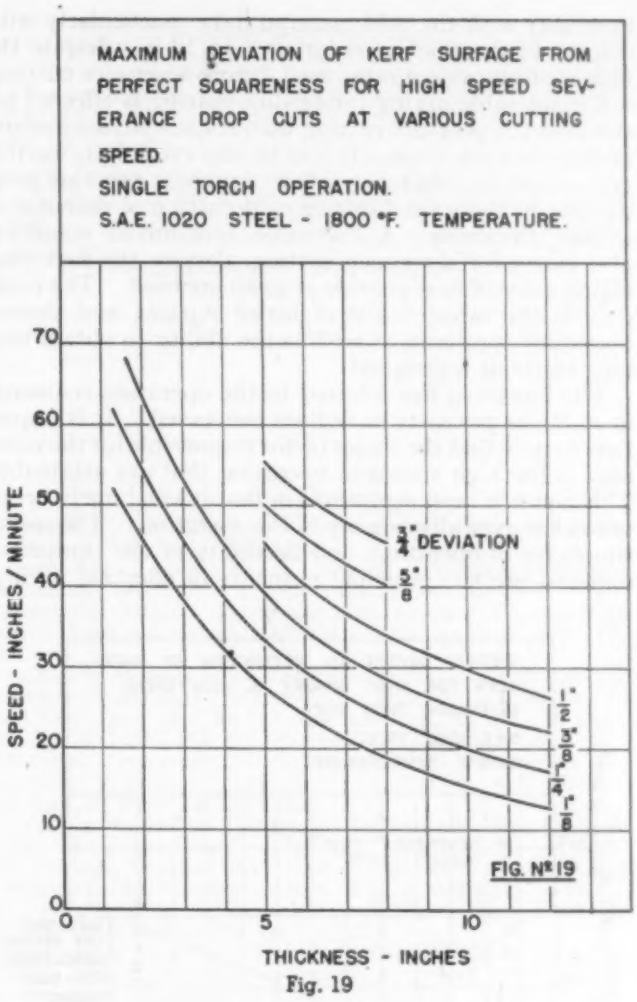


Fig. 19

Economy of Cutting at Elevated Temperatures

The economic advantages of the hot-cutting process can be fully appreciated by comparing the increased speeds of operation together with the costs of the oxygen and fuel gas involved.

Almost without exception, industrial hot-cutting applications require the production of drop cuts. This requirement on cold cutting operations is only achieved at the expense of lower operating speeds and increased oxygen consumption. At elevated temperatures, drop cuts can be made at high speeds that are only slightly below the maximum attainable prior to the promotion of "shelving." This is possible by virtue of the correct torch angularity and temperature which permits the oxygen stream to maintain the cut in the lower region of the work for a short interval after the oxygen stream has emerged from the kerf in the upper section. Oxygen economy is effected under these conditions inasmuch as appreciable drags at high speed operation may be tolerated while still retaining drop cut ability.

Figure 20 compares the specific oxygen ratios obtained for quality drop cuts at 1800° F. with those published[6] for cold material. The published values are admitted to be considerably lower than those achieved in the great majority of industrial establishments. Nevertheless, the curve for the hot cut material shows superior oxygen economy for all the thicknesses investigated. The tips used for the quality cutting were the divergent "basic oxygen" type.

Also plotted on Fig. 20 are representative severance drop cuts for various thicknesses of material. It will be noted that the oxygen economy of these cuts compare

favorably with the cold material data (particularly with respect to the thicker materials 8 to 12 in.) despite the high cutting oxygen rates used during severance cutting.

Considerable saving for quality cutting is effected for elevated temperature cutting with respect to fuel gas and preheat oxygen costs. It will be observed that, for this type of cutting, the rates of flow of preheat gases are comparable to those used during cold cutting of material of similar thickness. A favorable economical condition also exists for severance cutting, despite the fact that higher rates of flow of preheat gases are used. The economy is the direct result of faster starting and shorter operating durations, as well as the ability to obtain running starts at high speed.

The foregoing has referred to the operating economy, in so far as gas costs have been concerned. It is important to note that the major factor responsible for the economy is the high speeds of operation that are attainable. This factor is most significant in that it also largely determines the over-all economy of the operation. The speed, simplicity of operation, and flexibility of the equipment required are the principal elements in effecting savings

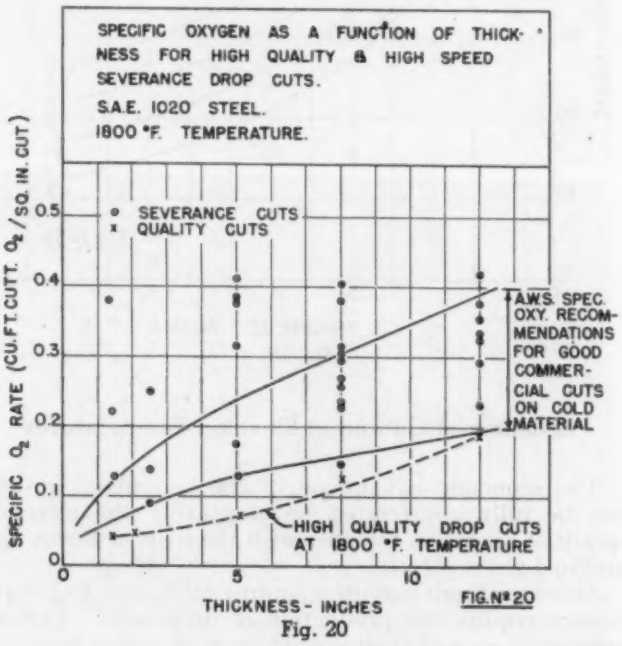


Fig. 20

on overhead, labor, and maintenance costs as well as capital investment when compared with competitive equipment and processes.

For the purpose of determining the most economical method of producing severence cuts, a knowledge of the specific problem is necessary. It should be remembered that increased speed is accompanied by quality deterioration and to some degree a sacrifice of gas economy. A balance can be arrived at wherein the speed requirements, allowable quality deviation, and gas and labor costs may be correlated to produce cuts of least cost that fulfill requirements. As an example of the preceding statement, Fig. 21*A* illustrates the type of cut originally requested for a specific requirement (maximum allowable deviation $^1/_8$ in.). Figure 21*B* shows the type finally accepted after the problem was completely analyzed. The benefits accruing from the increased speed more than justified the increased deviation of $^3/_8$ in.

Conclusions

The results of the investigations may be summarized as follows:

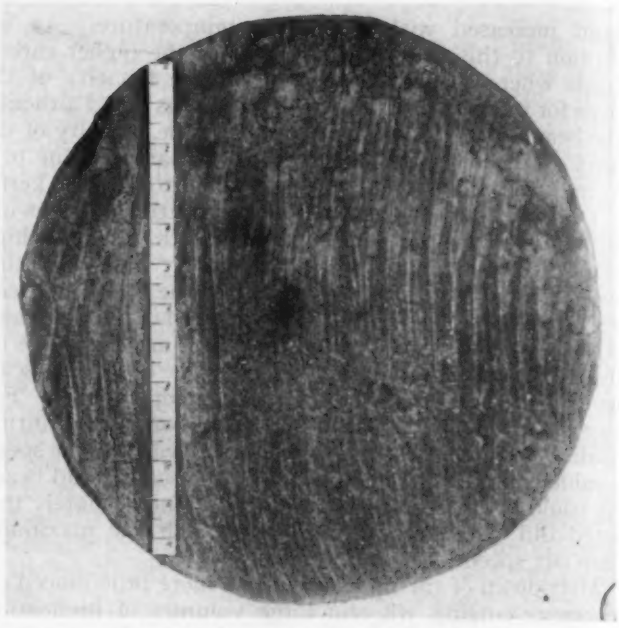


Fig. 21A—15-In. Round S.A.E. 1020 Cut at 1800° F. Average Speed 11 In. per Min. (78 Sec. Duration)

1. The oxygen cutting of steels at elevated temperatures (1400–2200° F.) conforms to the same general principles employed during cutting at room temperatures; also quality and dimensional tolerance may be controlled to a similar degree.
2. A test procedure has been devised for evaluating a "basic cutting oxygen flow rate" for each thickness of material. This is the rate which represents the most efficient utilization of oxygen.
3. For cutting oxygen flows above the "basic rate" for a given thickness two types of drop cuts can be obtained; i.e. quality and severance, the higher speeds of severance cuts being obtained at a sacrifice of quality. The dimensional deviation of severance from quality cuts has been correlated for various conditions of operation.
4. The relationship between the speed, cutting oxygen

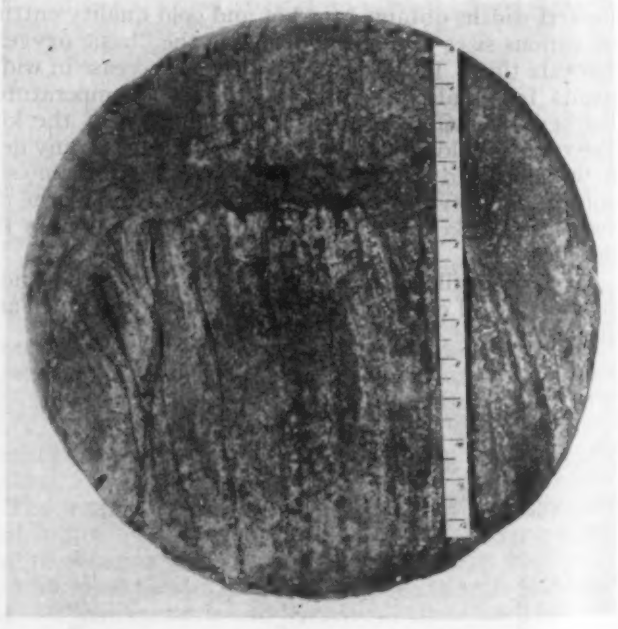


Fig. 21B—15-In. Round S.A.E. 1020 Cut at 1800° F. Average Speed 17 In. per Min. (51 Sec. Duration)

flow rate, carbon content, temperature, and thickness for severance and quality drop cuts has been established.

5. Improved operating techniques have been developed and a means of utilizing the cutting oxygen more effectively (dual torch) has been devised.
6. The economy, speed, and metallurgical advantages of the hot cutting operation make possible its incorporation in production involving the processing of steel at elevated temperatures.

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Development of Jacketed-Type Steel Drier Rolls*

By William H. Funk†

IN THE early 1930's, a welded steel single shell drier roll was installed as a replacement in a bank of cast-iron drier rolls. There had been a failure and the use of this steel roll was considered mainly because it could be obtained very quickly. This may not have been the first instance of the use of a welded steel drier roll. However it did provoke considerable thought and discussion because of the increased operating efficiency and longer bearing life through improved journal design which resulted. These advantages have continued over the more than 12 years of nearly continuous service rendered by the drier roll which is operating in a mill making paper board.

Here was a new field for fabricated steel. Since then steel drier rolls have been accepted by many different industries such as paper making, printing, textile, film processing, plastics, rubber and chemical.

This early single shell drier roll was a duplication of the over-all design of a typical cast-iron roll, except that the thinner shell and the heads were made an integral piece by welding.

Figure 1 shows this roll as it appears in the drying machine. The size of the roll is 3 ft. 6 in. O.D. by 10 ft.

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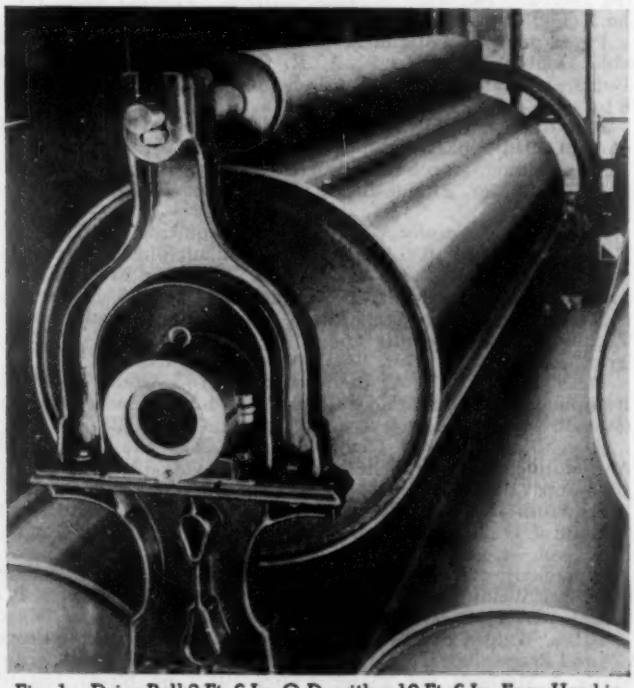


Fig. 1—Drier Roll 3 Ft. 6 In. O.D. with a 10 Ft. 6 In. Face Used in a Paper Manufacturing Process. The Drier Roll, with Shell and Head Made an Integral Piece by Welding, Duplicates the Over-All Design of a Typical Cast-Iron Roll

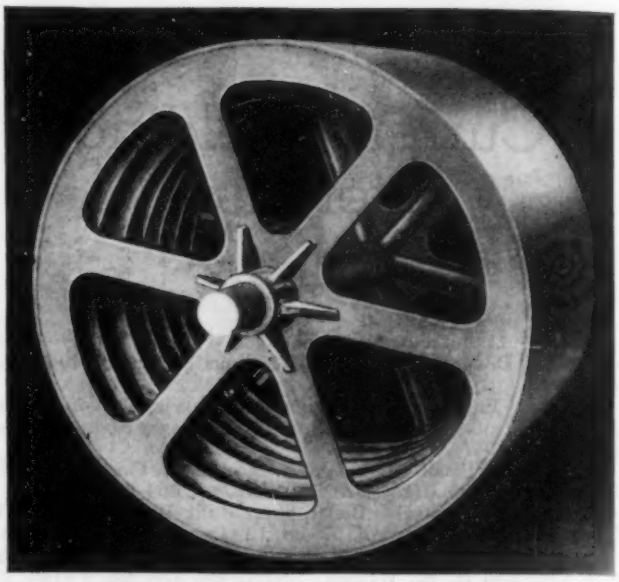


Fig. 2—Jacketed-Type Drier Rolls Before Machining. Each Is 6 Ft. 0 In. O.D. with a 5 Ft. 0 In. Face

6 in. face. The journals are designed with an insulating air chamber between the steam passage and the bearing to reduce the temperature on the bearing.

There were few who thought that this drier roll would be much different in performance than the conventional type generally in use. However, some engineers saw, through the use of fabricated steel design, the means of improving on several features inherent in conventional single shell drier roll design. A large diameter single shell roll requires very thick head sections which contribute substantially to the weight of the roll. If the steam were confined to an annular space between two shells, this heavy end design could be eliminated. The higher strength of steel plate would allow the use of lighter gages for the shells so that two shells plus internal stiffeners would weigh little, if any, more than a single cast iron shell. This weight reduction would be very beneficial in service. Figure 2 shows jacketed drier rolls of this design before machining. They are 6 ft. 0 in. O.D. by 5 ft. 0 in. face. The journals were machined for roller bearings and a drive gear, and the face was machined to a polished finish. Figure 3 shows a schematic drawing of a section of this roll. Note the absence of any heavy sections in these drier rolls.

In this double shell design the flat head plates, which close off the ends of the steam chamber and support the shells by spokes from the journals, also provide the means of passing steam into the annular shell space. Half-pipe sections, welded to the spokes, and holes drilled in the inner shell and journals, form a steam passage through one journal, across the face of the roll and out

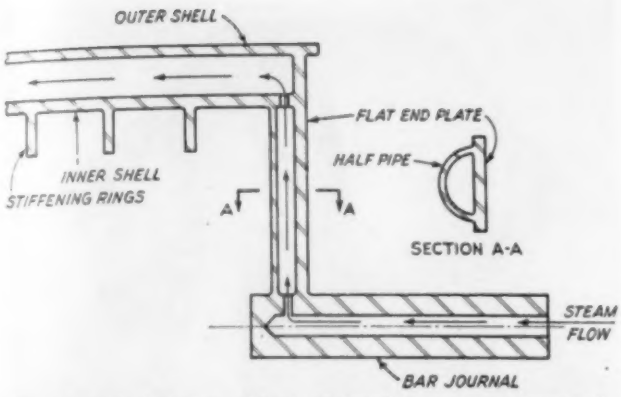


Fig. 3—Typical Design of Early Jacketed-Type Steel Drier Roll Showing One-Quarter Section of Roll

the other journal. Some of the earliest jacketed-type steel drier rolls designed and built in this manner were used by a publishing company to dry printed ink.

The next consideration in furthering the design of the jacketed-type drier roll was better condensate removal. Jacketed-type steel drier rolls already built were operating very satisfactorily and more were being fabricated. However, it was acknowledged that a more positive method of removing condensate should be incorporated in future designs. As a result a Yankee drier roll was built with two provisions for condensate removal incorporated in the design. Figure 4 shows this drier roll which is 8 ft. 0 in. O.D. by 6 ft. 10 in. face. Every section on this drier roll is now serving a double function since each piece is a strength member and is also part of a steam passage. The steam inlets have become pipe spokes and the end plates have become rings acting as closure plates only. The condensate provision used at slow speeds is a scoop arrangement and was designed to pick up the water lying at the low point of the drier and remove it. At higher speeds when the condensate rotates with the roll this scoop would not remove the condensate. A pipe, therefore, is inserted through the inner shell so that the open end of the pipe is very close to the inner surface of the outer shell. This pipe draws off the condensate leaving a water film, the depth of which is equal to the clearance between the pipe and the shell. Valves in these condensate lines make it possible to use the drier roll at any speed and still evacuate the condensate. The passage of steam in this drier roll is through one journal, into the pipe spokes at both ends of the roll, and into the jacket space, from the center of which, by one system or the other, the steam and condensate are removed through the opposite journal. The pipe spoke design is an improvement over the one used in the earlier drier rolls because in the current design there are no unheated sections to restrict roll expansion. Stiffeners on the inner shell have been eliminated. These drier rolls may be closed at the ends to keep heat losses from the inner shell at a minimum.

The operation of this first Yankee drier roll definitely indicated that the jacketed-type design was more efficient than a single shell design. The roll was first operated at the speed and steam pressure previously used with the cast roll it replaced. Flashing and burning of the tissue paper being made, resulted. To produce the paper satisfactorily the steam pressure was reduced to less than 5 psi. and the speed of the machine was increased. Later the pressure was raised slightly and the speed increased still further. This jacketed-type steel drier roll, currently produces more paper than was possible with the cast-iron roll, although it uses exhaust steam instead of live steam directly from a boiler. Tissue paper has been creped from this roll ever since it was installed and the doctoring action has not been detrimental in any way. This doctoring is a scraping action on the face of the roll, while it is in operation, for the purpose of creping, flaking, cleaning or polishing.

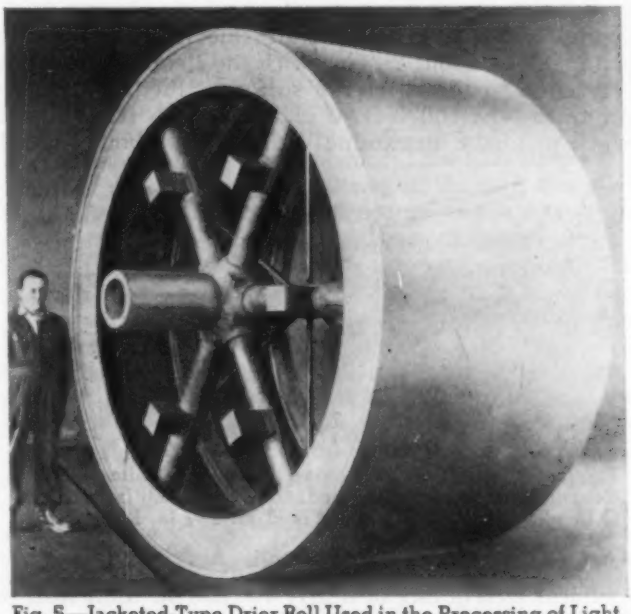


Fig. 5—Jacketed-Type Drier Roll Used in the Processing of Light Plastic Film. It Is 10 Ft. 0 In. O.D. with a 5 Ft. 0 In. Face and Weighs 18,900 Lb. The Over-All Journal Length Is 7 Ft. 10 In. Blocks Welded to the Spokes Are for Attaching the Driving Mechanism

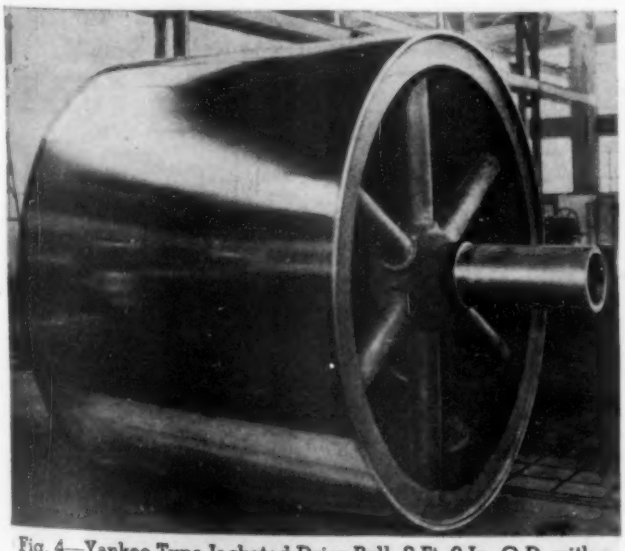


Fig. 4—Yankee-Type Jacketed Drier Roll, 8 Ft. 0 In. O.D. with a 6 Ft. 0 In. Face and Weighing 17,685 Lb. Each Section of This Roll Serves a Double Function as a Strength Member and as Part of a Steam Passage

The field of use for these jacketed-type steel rolls was also extended while the design was being developed. Jacketed-type rolls 10 ft. 0 in. O.D. were fabricated for use in the processing of light plastic films. The nature of the product requires that these rolls, designed to use warm water as a heating medium operate with a very uniform surface temperature. Figure 5 shows this roll unmachined with the small pipes through which the warm water is distributed, and the diffusing manifold inside the inner shell. The pipe spokes on each end of the roll are the return lines only. The heavy blocks on the

spokes are for attaching the driving mechanism. The face of the roll is later polished to a high finish.

A jacketed-type roll 2 ft. 6 in. O.D. was fabricated and chrome plated on the face for a pharmaceutical company to flake, by doctoring, a product of crystalline form. This roll has given trouble-free service for about seven years at an approximately 20% higher rate of production than that of similar units using single shell rolls. Figure 6 shows this drier roll ready to be installed in the machine. Notice that the end construction has been ribbed to provide additional stiffness for the unusually long journal. The end plates in this roll also have passageways to allow steam to get to the jacket space between the shells.

For high temperature requirements of around 700° F. jacketed-type rolls are supplied to chemical manufacturers. These rolls have a variation of the jacketed-design which may best be described as a labyrinth for the circulation of any special heating medium. Figure 7 shows such a drier roll with a cutaway section revealing the labyrinth design. Rolls of this type are particularly applicable for installations requiring very high pressures, very high or low temperatures, or where a heavy load is applied externally. The total thickness of the shell plate may be about $2^1/_2$ in., with the steam passages still very close to the outer roll surface. Figure 8 shows a labyrinth-type roll 6 ft. 0 in. O.D. by 5 ft. 0 in. face which will have an external belt load of about 6500 lb.

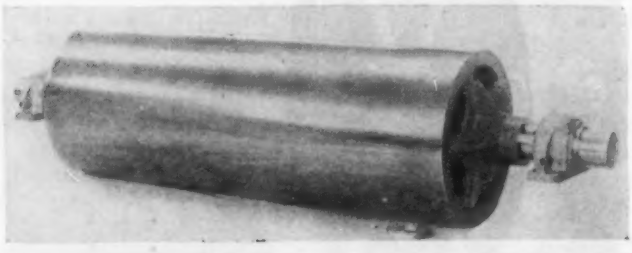


Fig. 6—Drier Roll for a Machine in Which a Saline Solution Containing 30% Solids Is Dried. The Drier Roll Is 2 Ft. 8 In. O.D. with a 7 Ft. 6 In. Face and Is 11 Ft. $3^3/_8$ In. Long Overall

per linear inch of face or nearly 400,000 lb. total load on the roll. The drier is designed to use steam at 150 psi. in the labyrinth-type construction of the shell plate.

The acceptance of these jacketed-type drier rolls for a variety of uses offers proof of their value in most industries where the principle of drum-drying is used or is applicable. The advantages to be gained by the use of this type of roll for drying, cooling or any other processing done on drum-type rolls can be grouped in several catagories First, welded steel fabrication makes possible a wide range of roll design from which a roll can be readily adapted to a specific use. Second, the design selected contains mechanical advantages that are not found in any other type rolls. Third, the jacketed-type steel roll also has features which will raise its operational efficiency above that of the conventional-type rolls. Fourth, these advantages generally reflect savings in initial costs, operating expenses and operating time.

The design of a jacketed-type steel roll is limited only by the imagination of the designer, who must, however, acknowledge certain physical limitations which cannot be overlooked. Among these are transportation problems. A roll 15 ft. 0 in. O.D., or larger, may be shipped provided the face width or over-all length is not too great. The fabricating facilities available must be considered. Can a cylinder 10 ft. 0 in. in diameter with a 16 ft. 0 in. face be formed from a plate of 2 in. thick steel? Are assembling and welding facilities adequate for the

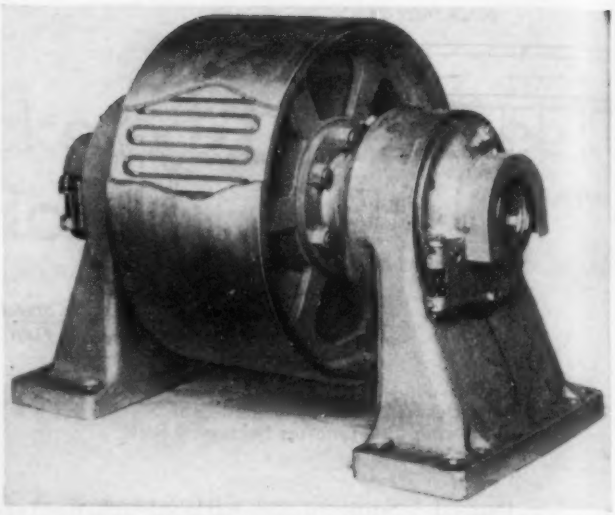


Fig. 7—Steam Platen Adapted for Use as a Drier Roll with Section Cut Away to Show Internal Labyrinth. In Operation, Cold Water or a Refrigerant Will Circulate Through the Labyrinth of the Drum. Drier Rolls of This Type Are Furnished from 2 Ft. 0 In. O.D. Upward

design contemplated? Are furnaces available to stress relieve a roll of the size desired? Stress relieving is considered a necessity if the roll is to hold its true shape in operation. The manner of stress relieving has also been found to affect the dimensional stability of the machined drier roll. Are the machining facilities available for a roll of the size contemplated and can the type of finish desired be obtained? These are typical limitations mentioned because they are the only kind of physical limits imposed on the designer. The costs of special patterns or dies do not have to be considered in designing a drier roll of any diameter or any variation of a standard design. The designer must also consider rigidity and strength under operating loads and pressures. Code requirements for pressure vessels must be observed in most installations.

These limitations are in no way alarming for the possibilities in welded steel designs are virtually untapped. Rolls can be made for higher pressures than were ever practical before. They can be made so that they will give constant and uniform temperatures over the face.

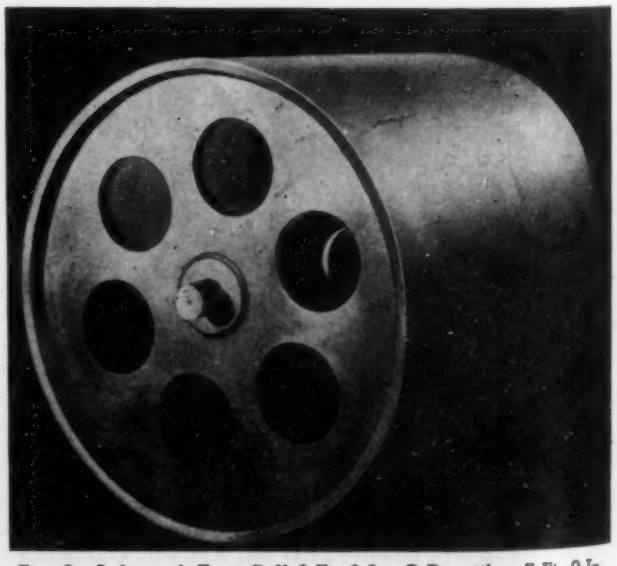


Fig. 8—Labyrinth-Type Roll 6 Ft. 0 In. O.D. with a 5 Ft. 0 In. Face Which Will Have an External Belt Load of 6500 Lb. per Linear Inch or Nearly 400,000 Lb. Total Load on the Roll

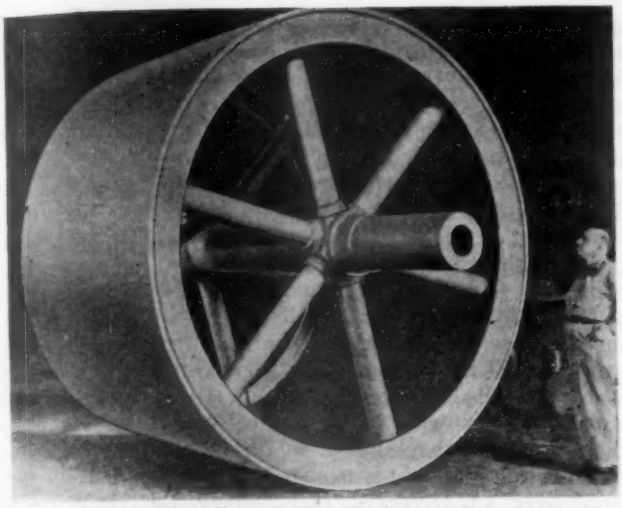


Fig. 9—Double Shell Drier Roll 10 Ft. 0 In. O.D. with an 8 Ft. 0 In. Face and 14 Ft. 5 In. Over-All Journal Length, Weighing 28,601 Lb. It Is Designed to Withstand 100 Psi. Steam Pressure

A jacketed-type steel roll also can be designed with solid stainless shell or with a clad steel shell to resist corrosion or prevent contamination of the product. The jacketed-type steel roll can be designed for use when chromium, nickel or other plating is desired on the face.

The mechanical advantages incorporated in the design vary to a degree with the size of the roll and the design selected. A jacketed-type roll 3 ft. 6 in. O.D. and under, will not be lighter than a typical single shell roll but larger diameter rolls do show an appreciable weight saving which is reflected immediately in the design of the supporting frames and in the drive unit for the roll or rolls. The bearings for the roll can be smaller because of this weight saving and also because the relative strength of steel versus cast iron permits designing smaller journal diameters. There is added mechanical safety in the use of welded rolls in case of failures under pressure. If, for any reason, too much pressure is applied to the roll, the steel plate will distort to a noticeable extent before fracture occurs. This reduces to a minimum the chance that a roll failure may cause property damage or personal injury due to a sudden explosion. With a welded roll there will be no bolted or riveted joints that may from time to time become loose and leak. Figure 9 shows a drier roll 10 ft. 0 in. O.D. by 8 ft. 0 in. face which was designed for 100 psi. steam pressure. The roll was machined under a water pressure of 100 psi. and was being prepared for a final hydrostatic test at 200 psi. when the pressure was accidentally raised much higher than the 200 psi. specified. Instead of exploding, the weakest section of the roll, which was the outer shell plate, distorted and relieved the excess pressure. The permanent distortion of the shell plate was the only indication of failure. Figure 10 shows this distorted shell plate. The maximum permanent set was about $1^1/_4$ in. Still higher pressure probably would have blown a hole in the shell, but there would have been few flying fragments. The outer shell of this drier was replaced and remachined. The drier roll is now in operation.

The welded roll, designed correctly for its intended use, has operational advantages over a conventional-type roll. The jacketed design, which is adaptable to most uses, guides the steam in a restricted area across the inner surface of the face of the roll. The net cross-sectional area inside the roll which contains steam is therefore much less than that of a single shell roll. If it were assumed that a jacketed type drier roll in operation has the same surface speed, operating pressure, rate of drying of paper and rate of condensation in the roll as does a single shell roll, one thing becomes apparent: the steam velocity in the jacketed roll must be greater by the same ratio as the net cross-sectional area is smaller. In considering what this greater steam velocity does in the jacketed-type roll it is found that, first, it reduces the film on the inner surface of the shell plate. This film offers considerable resistance to heat transfer through the shell. Second, it minimizes the possibility of dead steam in the roll. Steam is guided into this jacket through a series of inlets spaced around the roll in a manner designed to keep all the steam in the roll in controlled motion. Third, the feature not only of channeling all the steam but also moving it at a higher velocity, is better insurance that air in the entering steam will be flushed out immediately with the exhaust steam and condensate. Dalton's Law of Partial Pressures states that the total pressure exerted by a mixture of gases is equal to the sum of the pressure which each gas would exert if it alone would occupy the whole volume. This law can be interpreted to mean that any air in the steam chamber of the drier roll will cause the actual steam pressure to be lower than that indicated by a gage in the steam line. As a result, the temperature in the drier roll will not correspond with the steam temperature at that pressure. Just a small percentage of air in the roll reduces the drying rate of the machine. Fourth, the greater velocity of the steam and the guiding feature of the narrow steam passage maintain a more uni-

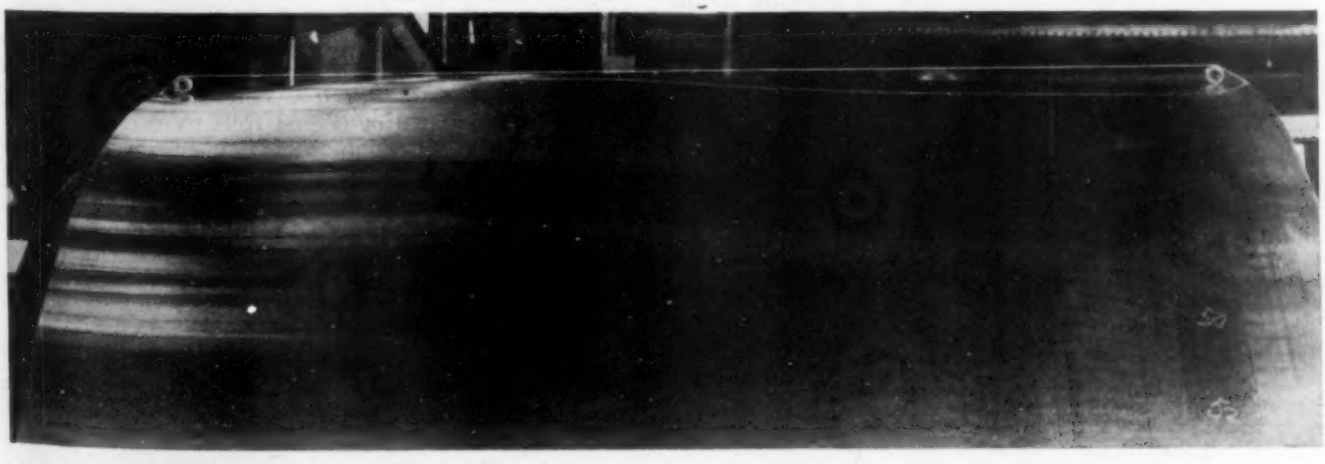


Fig. 10—Shell Plate Distorted by Excessive Pressure. The Maximum Permanent Set Was About $1^1/_4$ In. The Remainder of the Drier Roll Was Not Damaged. Since This Drier Roll Is a Weldment the Outer Shell Was Replaced and Machined and Is Now in Operation

$$Q = U \times A \times \Delta T$$

Where Q = Heat transferred in BTU/hr
U = Over-all coefficient of conductance in B.T.U./hr/sq. ft./°F
A = Area in square feet
And ΔT = Temperature difference in °F between the steam and the sheets to be dried.

The value for U can be derived from the following formula:

$$U = \frac{1}{\frac{1}{h_1} + \frac{1}{h_2} + \frac{1}{h_3} + \frac{1}{h_4}}$$

Where h_1 = Conductance of condensing steam
h_2 = Conductance of film on inside of shell (dirt, scale, etc.)
h_3 = Conductance of metal shell
h_4 = Conductance of film on outside of shell.

Fig. 11—Basic Formula for Heat Transfer

form surface temperature across the face of the roll. Also, the rate of heat transfer improves as the steam velocity increases.

By examining the assumption, with these features in mind, it is apparent that the rate of drying must increase because the conditions tending to retard heat transfer have been improved. Increased drying ability must be offset by increasing the operating speed if the residual moisture content of the sheet being dried is to be held constant.

Unfortunately, the nature of this increased operating speed, which is a measure of the productive efficiency of the drying machine, cannot be calculated to any degree of accuracy. There are too many indeterminate variables in a drier roll section of a machine in addition to the roll itself that have a direct bearing on the drying rate.

Figure 11 shows the basic formula for heat transfer.

Figure 12 shows the various components of the over-all conductance. The jacketed-type steel roll is not thought to affect appreciably the values of h_3 and h_4. It is known, however, that better heat transfer is obtainable from jacketed driers without altering the drying area A or the temperature differential ΔT, in Fig. 11. It is assumed then, that h_1 and h_2, the conductance of the condensing steam and the inner film, are the factors which cause this better heat transfer. How to evaluate this assumption is not definitely known. There is very much more development required before the best heat transfer rates will be obtained for the jacketed design. The only reliable methods known at this time, to measure the increased efficiency of a drying machine, which may be due to the use of a jacketed-type steel drier roll, are a practical test or by laboratory research. At this time, it should be pointed out, that regardless of the type and weight of the sheet being dried, a function of the drier roll is always to promote the evaporation of moisture from the sheet. Most of the heat absorbed during evaporation is supplied by the latent heat released when steam in the roll is condensed. Basically, then, a better heat exchanger will be a better drier, provided the additional heat is released through the shell and is not lost through radiation from the ends of the roll. To reiterate, increase drying ability must be offset by increasing the operating speed if the residual moisture content of the sheet is to be held constant.

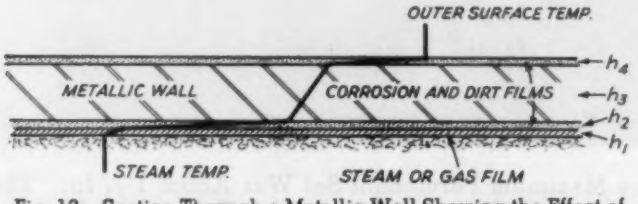


Fig. 12—Section Through a Metallic Wall Showing the Effect of Condensate, Corrosion and Dirt Films on the Transfer of Heat Through the Wall

A practical test performed in the following manner confirms the theoretical assumptions which have been mentioned. Ten jacketed-type steel drier rolls, 3 ft. 0 in. O.D., as shown in Fig. 13, were installed in a paper machine in a felt mill to replace 10 cast driers in a bank of 53 single shell cast-iron rolls. This felt mill produces the felt base for roofing materials and for floor coverings such as linoleum. The operating steam pressure for the cast-iron rolls was 50 psi. while the pressure of the jacketed rolls was increased to 150 psi. No other changes in the machine, or in its operation, were made. The production rate was increased approximately 8 to 10% over the average rate before the replacement. Where corresponding increases in pressure and temperature are possible this increased efficiency presents an interesting comparison. Keeping in mind that this installation has only 10 out of 54 rolls changed it can be figured that at 150 psi. pressure the jacketed drier rolls shows an increase in efficiency of from 40 to 50%. The efficiency increase, due to the increased pressure based on data collected from several sources, is estimated to be about 30 to 33%. The remaining increase in efficiency of about

Fig. 13—Jacketed-Type Steel Drier Roll 3 Ft. 0 In. O.D. with a 10 Ft. 0 In. Face and 15 Ft. 5¾ In. Over-All Length Designed to Operate at 150 Psi. in Contrast to Only 50 Psi. for Cast-Iron Rolls Used Previously

15% must be attributed to the jacketed steel design of the drier rolls.

In order to determine the relative efficiency of the jacketed-type steel drier roll at the original operating pressure of 50 psi., the pressure on the steel drier rolls was reduced to 50 psi. and observations were made with the machine running under conditions similar to those existing before the steel drier rolls were installed. Results indicated that the residual moisture content of the sheet was 28% less when the steel drier roll were used, and that the average operating speed was increased 4.6%. Again, noting that only 10 of the 54 rolls were replaced with steel drier rolls, it can be seen that each jacketed-type steel drier roll demonstrated an increase in efficiency of nearly 25%.

A conservative appraisal of this practical test indicates that 18% is a safe figure for increased efficiency of small diameter drier rolls. This figure is much more conservative for large diameter drier rolls and for Yankee drier rolls.

The jacketed-type steel drier roll effects savings in initial costs in several ways. For a desired production rate this type of roll in a new machine reduces the amount of floor space needed by reducing the number of driers required. This may mean actual savings in building costs. Medium to large size rolls are, by comparison, more economical to purchase. Accompanying frame and bearing costs are lower because of reduced weight.

The hazards in fabricating a welded steel roll are not so great as in casting a roll. The larger the roll the more apparent this becomes. If, for instance, a shell plate for a steel roll is damaged in processing it can be repaired or replaced for a fraction of the cost of casting a new roll.

Operational costs also may be reduced by virtue of reduction in weight and design. Lighter equipment requires less horsepower for driving. The jacketed-type steel drier roll requires no shutdowns for tightening bolts to stop steam leakage. The jacketed design reduces the time required to bring the roll to operating temperature. The usual starting delays are cut to a minimum whether the roll is operated with steam or with water because there is no large volume of cold water in the bottom of the roll to be removed or to be brought to temperature. For an equal number of driers, the operational costs per ton of finished product are reduced when the operating efficiency is increased.

Difficulties were encountered in developing the jacketed-type steel drier roll to its present status. Fortunately, however, they were generally fabricating problems and were confined to the weld shop. The experience gained through the solution of these problems has contributed greatly to the development of these drier rolls to their present standards. Data are available on the fabrication of nearly 200 steel drier rolls now operating in many different industries. All these rolls have satisfactory performance records and most of them have been contributing factors in increasing production on the drying machines in which they are operating. Only one of these rolls has given a purchaser reason to criticize its physical stability. This one roll, a Yankee drier, 10 ft. 0 in. O.D. developed an out-of-round condition within a year after it was put into operation. This out-of-roundness was confined to a flat spot over an area near the seam weld of the outer shell plate. The reason for this occurrence was traced to incorrect processing before the roll was machined. The method of processing was changed, and rolls fabricated since that time have maintained their size and shape satisfactorily. The out-of-round condition on 10 ft. 0 in. O.D. roll was not serious enough to prevent making tissue paper and napkin paper at speeds of over 1000 fpm. on it for four years before it was remachined to a true diameter. That roll is still operating at 1000 fpm. and should give no further trouble so far as dimensional stability is concerned.

There are certainly some problems which are yet to be overcome by the designers of jacketed-type steel rolls. Steel plate used to form the outer shell of the drier roll has been developed to provide the soundness required for any type of machine finish, including the highly polished surface needed as a base for plating. At present, however, a weldable steel is not available to give a surface hardness comparable to cast iron. This may or may not be detrimental when doctoring is necessary on the drier roll. Successful installations where doctoring is performed have been discussed. Additional research by both steel fabricators and manufacturers of doctor blades to improve this condition is still to be performed. Present designs available for jacketed-type rolls undoubtedly will be improved upon as more actual operating data are collected. The increased efficiencies known today are a challenge rather than a goal achieved.

The number of jacketed-type steel drier rolls in the process of fabrication or on order at the present time is between 250 and 300. It is apparent that the benefits to be gained by the use of this type of drier roll have been recognized and accepted. As more of them are put into operation it is believed that their acceptance will be still more widespread and that other industries will find use for this better drier roll.

Adams Lecture Series

In honor of its first President and Founder the AMERICAN WELDING SOCIETY created an honorary scientific lecture series known as the Adams Lecture. Each year the Lecture is awarded to some outstanding meritorious scientist or engineer. The reports have been issued in attractive pamphlet form and are available at 50¢ each. They are as follows: 1944—Solid Phase Welding, by A. B. Kinzel; 1945—Selection of Steel for Welding, by S. L. Hoyt; 1946—New Frontiers in Welding, by Wendell F. Hess.

The Welding of Stainless Steel for Jet Propulsion*

By E. J. DeWitt and F. J. Lammers†

DEVELOPMENT of jet propulsion in this country at the time of our entry into production was definitely primitive. Design was largely being developed paralleling steam turbine practice.

There is no forgetting the first introduction to the secret plant where pilot models were undergoing assembly at long rows of benches of the old world artisan type, each complete with various sets of anvils and mallets, as well as an assortment of special pries and levers.

One jet turbine nozzle, in a state approaching completion, was being blade-spaced—an extremely interesting and important operation. After watching the particular worker with great admiration, we were informed in answer to direct question that the worker had been doing the same thing for 18 years on steam turbines and was now almost as skilled as his brother working on the next bench. We were planning on making these with raw recruits—mostly women.

Why such skill requirements? Shrinkage and distortion in welding—accuracy in blade relationship and displacement. The turbine nozzle is in reality a metering diffuser. Its function is to distribute the gas, which by now has reached *almost* complete combustion, into the turbine. Without official published figures on the r.p.m. of these units, we will just say that the jet propulsion units are "revived" up very high. So high that any unequality in excess of a very low percentage figure would cause pulsation and ultimate destructive vibration.

To support the turbine nozzle blading in its frame (an air-cooled element sometimes at 60° or more below zero) and have at the same time a continuous flow of flame forced by a high-volume compressor pass through it requires flexibility. This was achieved by means of a bellows section.

As originally planned, the bellows was made as shown in the sketch Fig. 1. Because the diameter of the part

* Presented at the Twenty-Seventh Annual Meeting, A.W.S., Atlantic City, N. J., week of Nov. 17, 1946.

† Wallace Supplies Mfg. Co., Chicago 14, Ill.

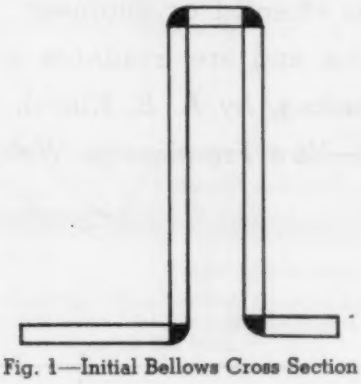


Fig. 1—Initial Bellows Cross Section

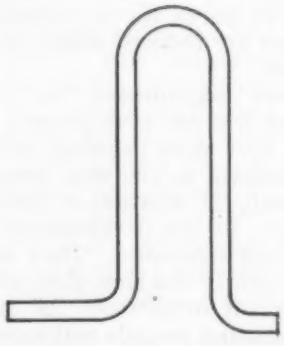


Fig. 2—Redesigned Bellows Cross Section

was approximately 3 ft. and there were five welds, this required approximately 50 ft. of welding on this steel, the maximum section of which was $^1/_8$ in. in thickness—the entire unit of which only weighed 90 lb.

The shrinkage problems, multiplied by tolerance restrictions, could have been, and in fact were being, overcome by the experience of the two highly skilled brothers who had been doing that for approximately 20 years each—but what about our untrained girls? The answer? Redesign! Eliminate every possible inch of welding. The typical cross section of the initial design, shown above, Fig. 1, having approximately 50 ft. of welding, was put through several design evolutions and resulted in the design shown in Fig. 2 below, having no welds at all, all these joints having been eliminated. This procedure was followed part by part until a minimum practical amount of welding (none in the bellows section) was realized. Every effort was then bent toward reducing the balance of the welds in the revised design. These were loosely broken into two classes—bond welds, or welds which fastened one subassembly to another, and spacer or blade welds, which located the spacers in the stator of the jet unit. Figure 3 shows a cross section of the initial design of the complete turbine nozzle with its total amount of weld, and the redesigned part together with its total amount of weld in Fig. 4.

All welding operators were women, recruited from household and other unskilled fields and trained in a special school of our own. First lessons comprised the usual striking of arcs, practice beads on flat sheets without joints, and elementary work in mild steel. Then stainless scrap was used for simulated joints until a typical production weld could be made proficiently and with sufficient skill for air corps certification. The newly certified welders were not put directly into production, however; they went through a secondary school in which inspection report quality and productivity were rated, and skill gradings assigned, which were bases for both compensation and upgrading.

Production workers were similarly rated and weekly

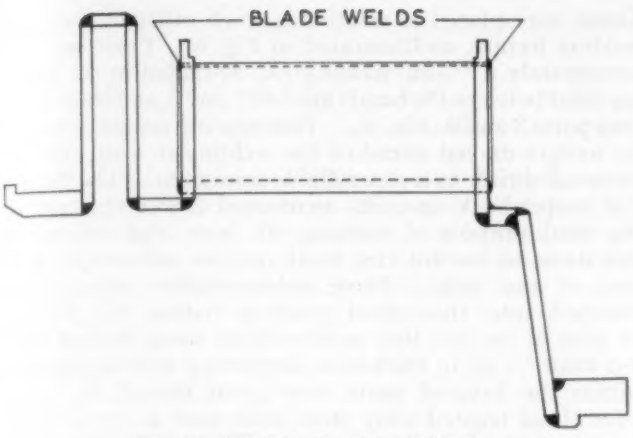


Fig. 3—Initial Nozzle Cross Section

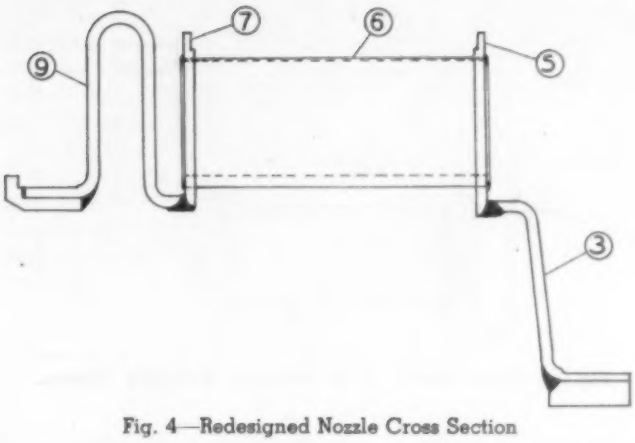


Fig. 4—Redesigned Nozzle Cross Section

reports graded, analyzed and distributed. These records were distributed to acquaint the welders with their progress; they also were used by group leaders and supervisors in directing work assignments and additional training. This procedure was an important advantage in dealing with both the training and productive phases of personnel problems with recruit welders, and yielded results with many who were otherwise somewhat unpredictable in performance.

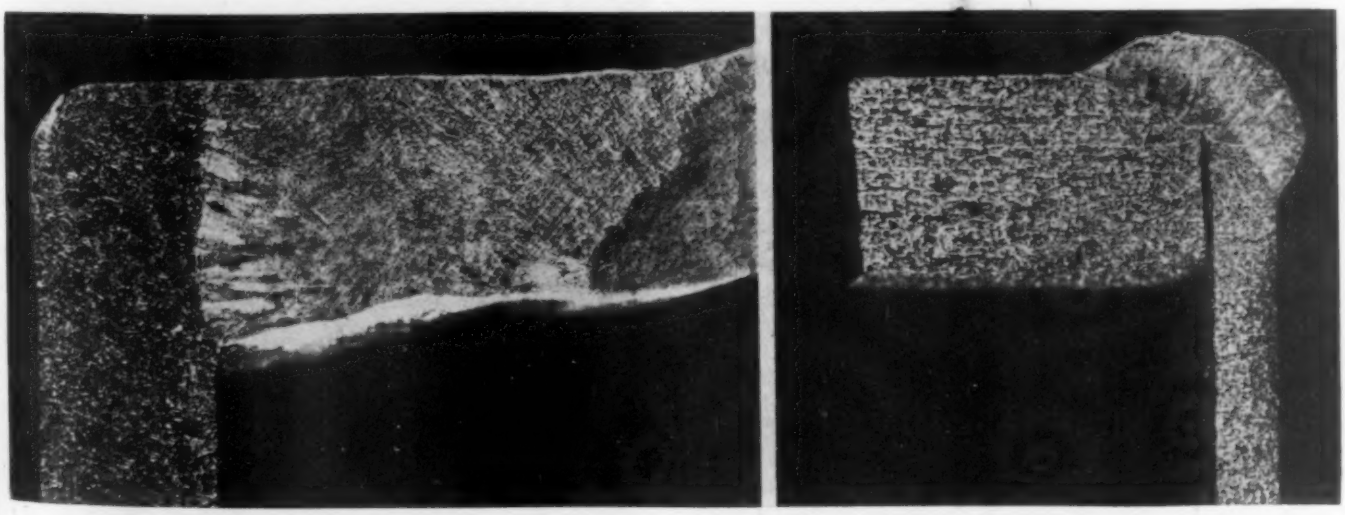
Since the tolerances were so tight, it was very important that the amount of weld deposited on each seam vary from the theoretical by only a very slight amount. The units themselves were too expensive for trial pieces, so simulated setups were necessary. Each welder with these sectional fixtures was put through her paces until the results approached a predictable answer. However, the sections were only segments and not circles. How much to allow on the diameter to shrink to the proper machining tolerance?

Careful analysis was made of the procedures used in trial runs. When repeated, using the recorded procedures and watching particularly the element of time consumed, there was produced a sequence of units which attained the tolerance requirements.

In Fig. 5 are photographs illustrating the typical weld cross sections. The weld area has been retouched in these photographs to fully delineate and outline form and general area. Probably the most difficult welds were the pair which bonded the blade ring, parts 5, 6 and 7, to parts 3 and 9 (Fig. 4). Satisfactory penetration, reinforcement, uniformity and constancy of time for metal placement were of prime importance. These, with the very complicated fixtures (copper backed to produce quenching and provide proper dam action for the molten flux under the weld) seemed to overcome this problem. Needless to say, the fixtures were developed after considerable pre-experimental work, using simulated sections.

In holding distortion to a minimum on these complicated assemblies, it was necessary to take into account than just weld shrinkage. There was, for example, in addition to the shrinkage anticipated due to the weld bead, a secondary distortion due to creep which welding procedure alone could not be guaranteed to correct. Actual bead shrinkage may distort parts sufficiently, even when assembled tightly in a fixture, so that an accumulated creep occurs between parts not yet solid welded, even though they may be tacked. This differential shrink, as we called it for want of a better name, was caused by the circumferential differential between the two parts being welded and was particularly deceptive, since it usually did not crack tack welds, nor exhibit itself until the fixtures were unclamped.

We found more trouble from differential shift in connection with welding the blade and band assemblies. They shifted both out of plane and radial alignment, lost concentricity as well as annular spacing. The only cure for this was repeated development and change in



Bond Weld Blade Weld

Fig. 5—Typical Weld Cross Sections—Macro Etched. 10 ×

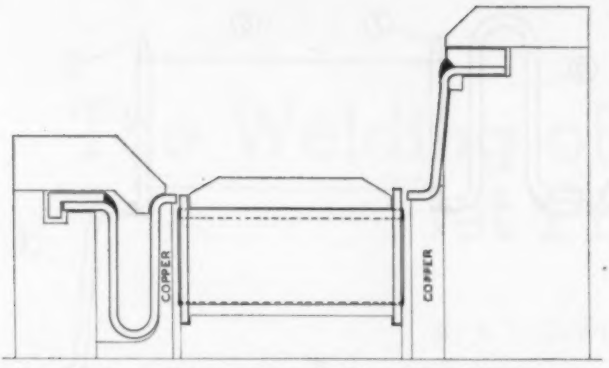


Fig. 6—Cross Section Final Welding Assembly Fixture

both subassembly sizes and tolerances, and in the use of rigid fixtures in the simultaneous tacking by two operators working on opposed portions of the blade-band joints, moving at 45° intervals, progressing until the entire subassembly was tacked, repeating this procedure on the same assembly until the entire unit was completely welded. In this subassembly were approximately 640 lineal inches of $^1/_{16}$ in. fillet.

A maximum production on this subassembly was reached when the time was reduced to approximately one hour setup and one hour for welding time, with the use of two operators. However, while speed of welding was necessarily of prime importance in the initial shrink in the fixture, the dimensional results were affected by the secondary aspect of distortion—that of creep within the fixtured and tacked parts prior to their being welded, as the result of expansion and contraction of local high intensity in other areas being solid welded. By allowing more time, these local effects were distributed more uniformly with improvement in tolerance control. Tolerance control achieved by each system is tabulated below.

	Plane, In.	Ovality, In.	Concentricity, In.
One-hour weld time	0.085	0.060	0.043
Two-hour weld time	0.025	0.039	0.043

Three assemblies went to make up the final unit. These were placed in relation to each other in a master welding fixture, as illustrated in Fig. 6. There was approximately a $^1/_{16}$-in. welding gap provided in the welding joint between the bands marked 7 and 5, and their adjacent parts 3 and 9 (Fig. 4). This spacing was maintained by wedges moved ahead of the welding to keep circumferential shrink to a controllable minimum. The fixture had copper back-up units, mentioned earlier, that served the dual purpose of running off heat and served as flux dams to control the bead on the submerged portion of the weld. These subassemblies were firmly clamped into theoretical position within the fixture. In spite of the fact that most sections being welded were less than $^1/_8$ in. in thickness, temporary welding stresses within the fixtured parts were great enough to break $^3/_8$-in. heat treated alloy steel bolts used in the original design of the hold-down units. These bolts later had to be doubled in strength.

The initial technique developed for the parts 3 to 5 and 7 to 9 resulted in a weld being made in one piece with what amounted to a manually controlled submerged arc. This gave necessary root penetration in this very difficult joint; special bevels or other means of joint preparation were unsuccessful in yielding equivalent penetration. Due to seal ring fits and high velocity gas flows, no undercut or irregularly sized welds were permissible, nor any lack of penetration on the root side. Welds were cleaned completely with stainless brushes before inspection, which included height for machining cleanup. A reinforcement bead was laid on top of the finished weld in later procedures to provide greater cleanup height for changes in machining operations.

The parent metal in bands and blades was type 310, higher in chrome and nickel than 347 or 321, but without columbium or titanium stabilization. Carbide precipitation at the weld zone, in varying degrees, is illustrated by the photomicrographs in Fig. 7. Its occurrence and extent varied much more than seemed likely from any possible changes in production procedure; a satisfactory reason for this was not reached. Very likely the material itself—although its analysis checked to specification consistently—varied considerably in its sensitivity to intergranular precipitation.

Typical tolerance controls achieved by the single pass build-up and multiple pass bond welds on the difficult corner joints of 5 and 7 bands are tabulated below:

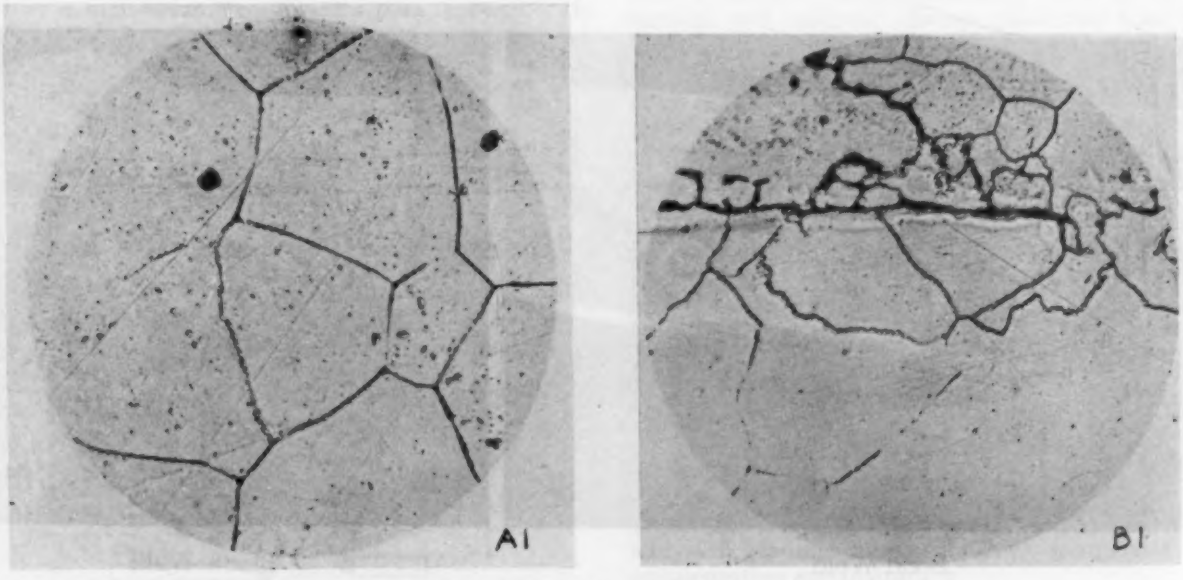


Fig. 7—Intergranular Carbide Precipitation in Parent Metal. 500 ×

	Plane, In.	Ovality, In.	Concentricity, In.
Single pass	0.06	0.057	0.075
Multiple pass	0.18	0.033	0.041

The single pass welds held circular parts in plane much better than multiple weld joints; but the lower intensity and more rapid distribution of heat in multiple welds permitted closer control of radial tolerances, which were too difficult to realign after welding.

Working out weld procedures in these ways, permitted a final choice that best suited over-all efficiency. Welding results, alone, might indicate superiority for one method, but subsequent requirements often override considerations which judge only the efficiency of a welding procedure in itself.

To repeat and summarize—welding problems in stainless, like most others, can sometimes be solved by keen analysis and procedure study; others by patient endeavor and endless trial development; and some can be met most successfully by redesign to eliminate the weld entirely.

Ryan Welding Innovations

By William P. Brotherton†

IN THE year 2000 B.C. some primordial metallurgist alloyed copper with tin to get bronze—a 14th century individual fused iron and carbon to make steel—and in the 19th century, man successfully welded one ferrous metal with another. Since these metallurgical milestones, no period in history has been so productive of fast new welding techniques than the past five years. The urgency of the need for fighting machines in World War II turned every industrial plant into a vast laboratory for finding streamlined methods of fabricating metals.

Under this intense impetus, the Ryan Aeronautical Company, one of the world's outstanding producers of aviation exhaust systems and airplanes, forged ahead in the race to join stainless steel. This Company perfected rapid welding methods to "stitch" together over 100,000 huge stainless steel exhaust manifolds for the engines of America's warplanes.

† Technical Editor, Ryan Aeronautical Co.

Fig. 1A

Fig. 1B

Fig. 2A

Fig. 2B

Frederick S. Dever, Welding Supervisor at Ryan, devised a new type of oxyacetylene gas welding torch which has two tips (Figs. 1*A*, *B*). This torch steps up the production of exhaust systems by performing two operations simultaneously; trimming the extra flange metal and welding the seam. Previously, it was necessary to trim this flange with a "jitterbug" cutter and then spot-tack the sections together prior to seam welding.

The tips of the torch direct the heat against opposite sides of the flange. The outside tip has a smaller diameter because it is the pre-heating tip. It pre-heats the

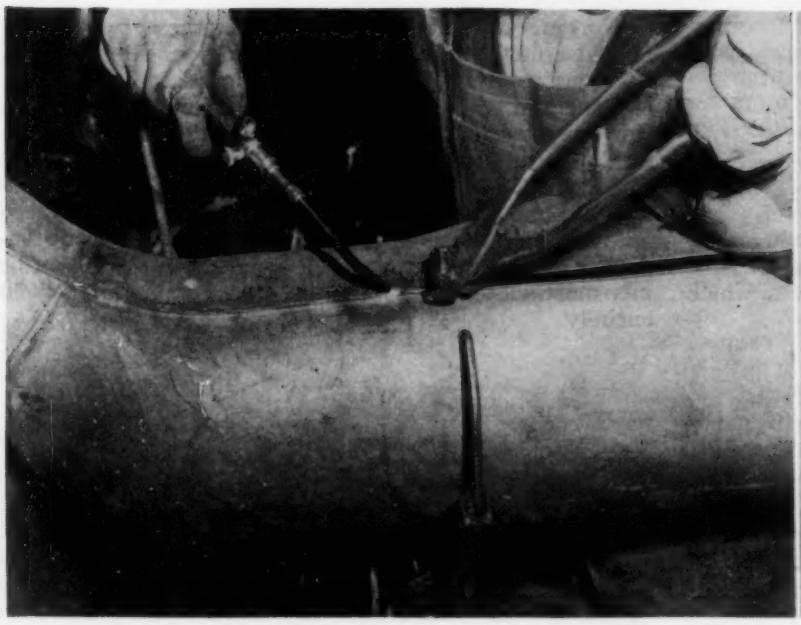


Fig. 3A

Fig. 3B

metal and permits the welding speed to be raised from $2^1/_2$ to $7^1/_2$ in. a minute. One adjustment takes care of both tip flames. The increased temperature derived from two tips both strips the flange from the assembly and welds the remaining seam. Another unique welding torch which Dever designed and built for Ryan has three flame tips; a special pair of natural gas tips in addition to its oxyacetylene tip (Figs. 2*A* and *B*). The natural gas is burned ahead and behind the welding tips to provide preheating and postheating of the stainless steel. Natural gas flows ahead of the weld zone to preheat the metal and escapes through tip perforations to maintain weld area temperature after the weld is made. This postheating is done so that the material will not cool too rapidly behind the weld and cause cracking.

Stainless steel has a high coefficient of expansion, twice that of mild steel, and therefore it is particularly subject to distortion. The effect of too abrupt a heating before, and cooling after, the weld causes a scissors-like stress which cracks the metal. The greater the welding rate, the more pronounced is this effect. Yet, rapid welding of stainless steel is very desirable because it reduces the loss of corrosion resistance of the steel. With this new torch, welding speed can be increased to six inches a minute with excellent results.

An advantageous feature of this welding torch is the prevention of oxidation of the metal by the flow of postheating gas which protects it from the air.

In order to prevent oxidation of the internal weld seam in long closed sections, a novel technique is utilized. Natural gas is introduced into one end of the structure and the other end is sealed with wet asbestos. As the gas burns within the tube it reduces the atmosphere and effectively prevents the oxidation of the weld area by consuming the available oxygen.

Two valuable tools which Ryan designed to simplify the welding job are the tacking pliers and adjustable clamp (Figs. 3*A* and *B*). These pliers are used to align and hold the edges of a flange for spot tack welding. The faces of the pliers are ground and hard-surfaced with Stellite. In addition to the claws, there is a metal finger which extends down between the flange edges and lines them evenly for spot-tacking. Gas tacking, instead of

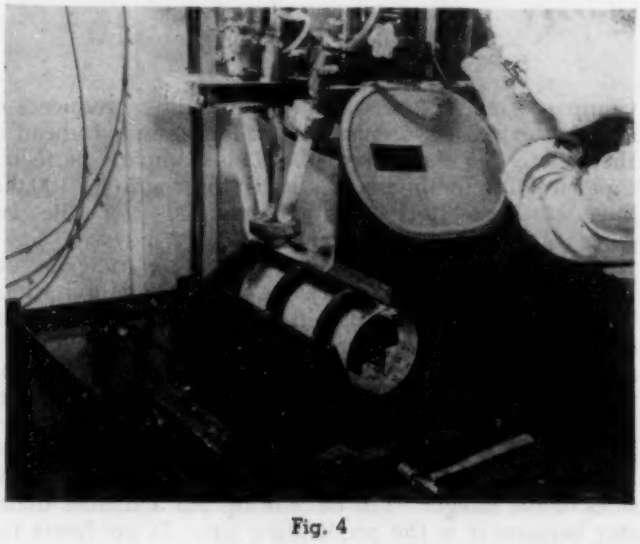


Fig. 4

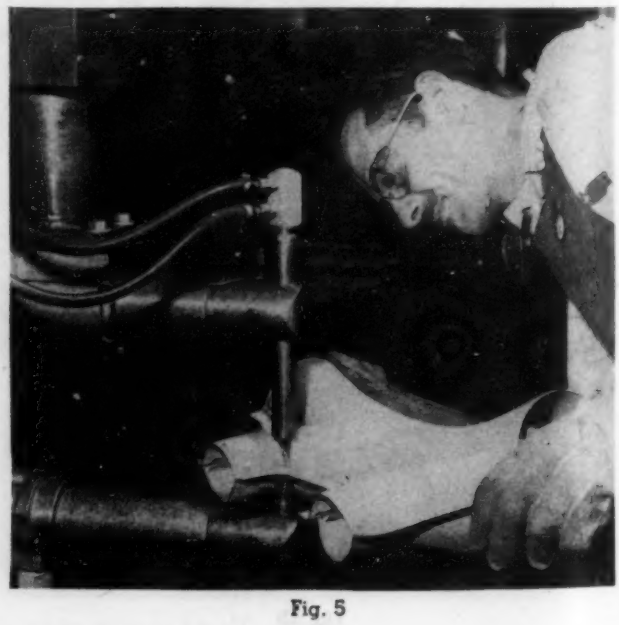


Fig. 5

Fig. 6A

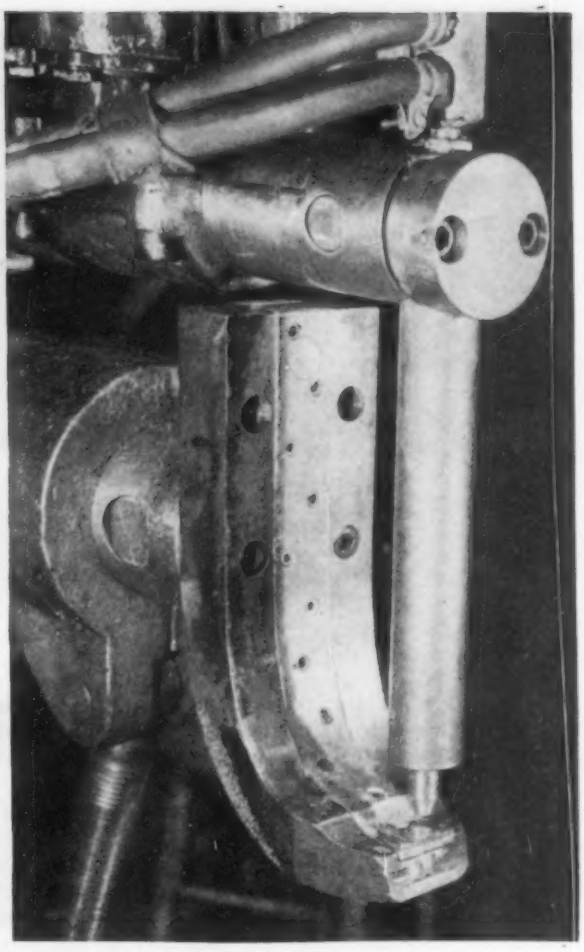


Fig. 6B

spotweld tacking is used on structures of this type because of their large and complex shape. The clamp, snugly holding the steel section, is an adjustable model which fits any diameter. It extends down to a special ball and socket swivel for positioning in any plane.

The Ryan Aeronautical Co. was one of the first air craft companies to install atomic hydrogen welding equipment in 1939. This process had proved itself superior in many ways in other industries but little information was available upon its use with the light-gage stainless steels of aviation. The Company designed light-weight electrode holders weighing half as much as the standard holders supplied with the equipment. These torches made it possible for large numbers of women to be used in the atomic welding program. At Ryan, 90% of the wartime atomic welding operators were women.

Atomic hydrogen is one of the cleanest and fastest methods for joining stainless steel. It adds no undesirable carbon to the welded metal costs about one half as much per foot of weld seam as oxy-acetylene gas. It derives its speed from the extra heat obtained from the molecular change of the hydrogen gas which is added to that generated by the arc stream. The hydrogen absorbs energy as it passes through the arc and changes from molecular to atomic in structure. Upon striking the metal, it is transformed back into its molecular form, releasing large quantities of heat.

In addition to increased speed and reduced costs, atomic hydrogen produces a more ductile weld with superior microstructure. It lends itself nicely to the design requirements of the exhaust manifold industry.

To attain top speed in the welding of tubular sections of stainless steel with atomic hydrogen, there was designed and built an automatic conveyor machine which makes automatic atomic welding possible (Fig. 4). Fast, smooth welding at the rate of 28 in. a minute is performed by these machines. This rate forms a striking

Fig. 7

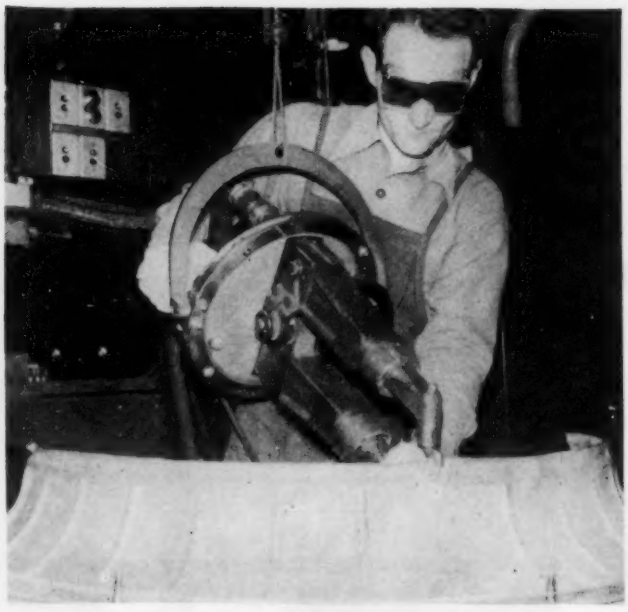


Fig. 8

comparison with the oxyacetylene rate of 5 in. per minute or the 10 to 12 inches for metallic arc welding.

One of the greatest aids in taking the manufacture of exhaust manifolds from a hand method to a mass production system, was the development of the use of rapid "spot-tacking" for the assembly of stainless steel half-stampings. Before this innovation, the half-stampings were taken from the drop-hammers, thoroughly cleaned and assembled with clamps for seam welding. The parts had to be very carefully held together in the clamps so that the edges would fit correctly for the seam welding.

With the new technique, the half-stampings are quickly spot-tack welded together without the need for adjusting holding clamps (Fig. 5). The operator holds the parts in alignment while as many as 120 spots per minute are located to "stitch" the parts together prior to the seam welding.

Many unusually shaped electrodes are used to spot-weld odd or hard-to-reach assemblies. Erich Faulwetter, Sheet Metal Supervisor, designed a large electrode of heat-treated steel, with high strength to prevent deflection, and a copper insert for good conductivity (Figs. 6*A* and *B*). It was developed to permit the spot-welding of an extremely inaccessible structure by insertion into a narrow opening. The upper electrode is water cooled.

A long-type spot welder, which has a mechanically operated pressure device has been very useful in the spot tacking of an engine cowl (Fig. 7). Pressure is exerted by a lever arrangement. This tool has a solenoid switch control for timing the discharge of current and extra long electrodes for reaching remote areas.

Perhaps the most novel spot-welding machine in the plant is a portable gun built by the Sciaky Welding Company (Fig. 8). Although this welder weighs 60 pounds, it is easily handled by a woman because it is suspended by a counter-balanced cable which holds it in any position. The electrodes are air pressure operated and water-cooled. Because it can be inserted into narrow openings of less than $3^1/_2$ in. of vertical clearance, it is employed for many difficult jobs of spot welding such as the fabrication of engine cowlings and fire-walls.

Fig. 9

No story about welding methods would be complete without mention of the fast accurate metallic arc process. With this means, the amount and location of the heat application can be more closely controlled. The melting starts and stops with the arc. By varying the current, exactly the right amount of heat for good fusion can be applied. Careful selection of filler rods must be made to insure that the added metal will not disturb the balance of the stabilizing agent or the carbon in the weld metal.

Probably the highest quality weld which can be made is accomplished by flash welding machines which bring two edges together in butt-to-butt fashion and establish an arc between them (Fig. 9). When the metal becomes molten, the arc is extinguished and the two edges are pressed together, or forged, in a shower of sparks. This weld will be free of impurities resulting from exposure to the atmosphere at high temperature because a blanket of molten metal, which is later expelled, protects the plastic weld zone.

The contributions which the metallurgists and other laboratory scientists have made to the advancement of welding practices are enormous. Working with the metallograph, the spectrograph, carbon determinator and many other marvelous research machines have paved the way for metal progress.

We should not, however, forget that the welding supervisor, the plant engineer and the actual welding operator have all supplied industry with a generous share of their know-how to obtain our modern welding techniques. Most of the streamlined procedures and new devices in this field have been introduced by these experienced men and women who put their practical resources to the solution of industrial problems.

H-Section Welded Trusses*

By A. T. Waidelich†

THE art of structural welding has not shown the same versatility and freshness of approach that has characterized welding in the field of machine design. In structural welding—except for rigid frames—there is still a marked tendency to think in terms of adapting a riveted design to welding, with the result that the full economies and advantages of structural welding often are not obtained. In developing the H-Section Welded Truss, The Austin Co. had an unusual opportunity to discard all previous conventions and start out with a completely unbiased viewpoint. The resulting structure is a striking example of the advantages of structural welding: It is simple and clean-cut in appearance, easy to maintain and is not only an economical truss but also permits other economies in the erection of the buildings of which it is a component.

As used in this paper, the term "H-Section Truss" refers to a truss in which all members are conventional, rolled H or I sections with the webs of all members lying in the *same, vertical* plane, and with all connections made at abutting surfaces of these H and I sections by fillet welds.

* Presented at the Twenty-Seventh Annual Meeting, A.W.S., Atlantic City, N. J., week of Nov. 17, 1946.

† Assistant Director, Research Division, The Austin Co., Engineers and Builders.

Development of the H-Section Truss

This research development consisted of several episodes spread over more than two years: (1) an analysis of the problem; (2) the design of the truss; (3) an extensive program of testing, including loading two 50-ft. trusses to failure and a strain gage test of two 80-ft. trusses.

To understand the special conditions which led to this research development it is necessary to review the background of the Austin "standard trusses." Single-story industrial plants with aisles wider than 40 ft. contain large numbers of roof trusses. For the same span and spacing these trusses differ only slightly since the principal variations are usually in the roof live load and the type of roof deck. Therefore, as long ago as 1913, The Austin Co. found that there was a real economy in adopting "standard trusses": single and double pitch trusses of 50-, 60-, 70- and 80-ft. span which were pre-designed and pre-fabricated for a selected live plus dead load, which would include the majority of all loading and layout conditions for single-story industrial plants. These standard trusses were used even where the actual loads were somewhat less than those for which the standard trusses were designed, because the economies in mass production from a stock jig were greater than the small saving in weight that would result from the individual design and fabrication of a special truss.

In the early thirties these standard trusses were changed to an all welded design, using tee-sections for the chords and web members, thus effecting about a 20% reduction in weight over the previous riveted trusses. Thousands of these welded standard trusses were used successfully in more than 500 plants during the ensuing years, but a survey made in 1943 disclosed that in about 22% of the Austin single-story buildings with 50-, 60-, 70- and 80-ft. spans standard trusses had not been used. A research project was then authorized to determine the reasons for their non-use, with a view to modifying the standard trusses so that their economy could be extended to practically all single-story buildings of such spans.

This investigation showed that one important reason for the use of specially de-

Fig. 2—Standard Trusses Were Used Even Where the Actual Loads Were Somewhat Less Than Those for Which Standard Trusses Were Designed, Because of Economies in Mass Production from a Stock Jig

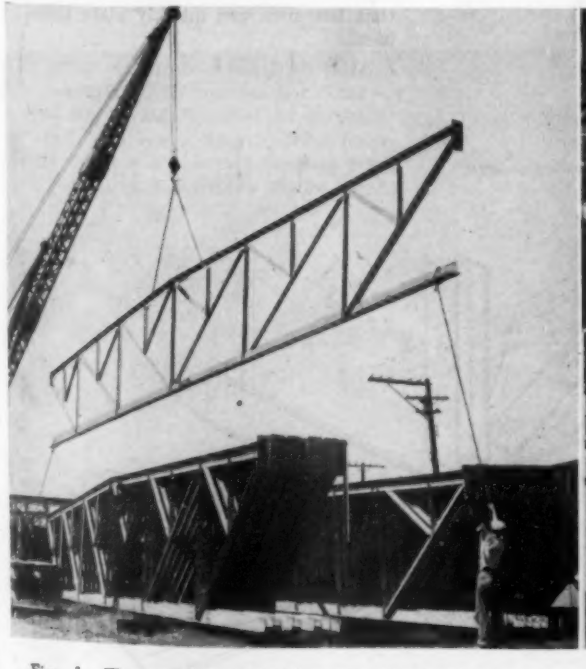


Fig. 1—Thousands of Welded Standard Trusses, in Which Tee Sections Were Used for the Chords and Web Numbers, Were Employed in More Than 500 Plants Between 1930 and 1943

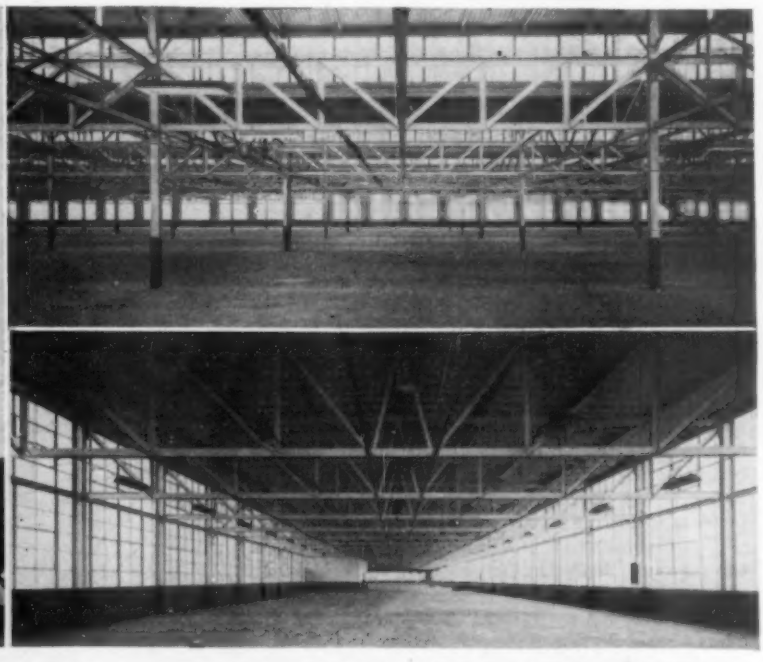


Fig. 3—Prior to Development of the H-Section Truss the Support of Monorail Systems Frequently Required Special Truss Designs

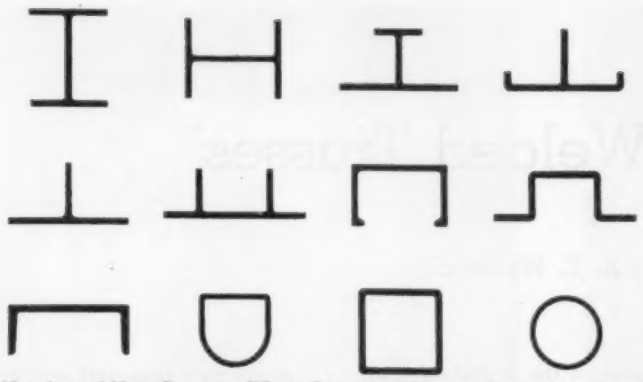


Fig. 4—A Number of New Sections Were Considered in an Attempt to Develop Standard Trusses So That Their Economy Could Be Extended to Practically All Single-Story Buildings with Standard Length Spans

signed roof trusses was that variations in purlin spacing and in the location of monorail supports or other loads on the bottom chord frequently required rearrangement of the panel points. A logical solution was therefore to use a section for the top and bottom chords that was capable of carrying bending as well as direct stress.

Since thousands of these trusses would be built, a special chord section was entirely feasible and for some weeks all possible sections and combinations of sections were carefully considered. The steel mills had indicated a willingness to roll any new section which might be more desirable and new profiles were given careful study. But when all factors were considered, the conventional wide-flanged H-beam proved to be the best for the chords of the trusses.

buildings. It is essentially a single-plane truss and therefore is limited to spans for which single-plane trusses are suitable. However, it is an extremely adaptable truss since it was found that by simply changing the weights of the truss members—but not their depths—the truss could accommodate increased or unusual loading conditions without changing the jigs which are required for economical fabrication.

Advantages of the H-Section Truss

The H-Section Truss has a number of advantages:

1. The full economy of welded design—the entire section of every member is available right up to its end connections.

2. Adaptability to a variety of loading patterns. Without changing the panel points, monorails and purlins can be located where desired, since both chords can take bending as well as direct stress.

3. Simplification of many construction details. With a beam section for a bottom chord, the top flange provides an ample seat for pipes and ducts and a monorail crane may be operated directly on the bottom flange. Furthermore, steel erection crews have found that it is easier and safer to work on this type of truss.

4. Since a fillet weld is run completely around all members at their end connections, all cut edges are covered and only the original rolled surfaces are exposed. This increases resistance to corrosion and simplifies painting and maintenance.

5. Marked economy in fabrication. The economy in fabrication is extremely important and is evident from the few operations that are required: cutting the members to length, assembly and welding.

While the chord members are cut with a large friction saw, the web members are cut with an abrasive saw to the exact angle required. Since the truss members are abutting instead of lapping, it is important that they be cut to exact length and angle. A satisfactory procedure for accomplishing this has been established by the use of these two types of saws.

Assembly of the truss members has been reduced to a simple "laying in place" by the use of stock jigs. These jigs are an important factor in the fabrication of the H-Section Truss. Not only do they reduce production costs but they insure accuracy in the assembly by making certain that the webs of all members lie in precisely the same plane. The initial expense of these jigs is considerable but is justified by the fact that these are standard trusses of which hundreds will be fabricated for many years to come. Monorail hoists are used to place the chords, but the short web members are generally so light that two men can quickly place them by hand.

After the truss is assembled in the jib it is tack welded and then removed and stood on its bottom chord. All bottom chord joints are then welded. Next the truss is turned upside down and all top chord joints welded. This simple tech-

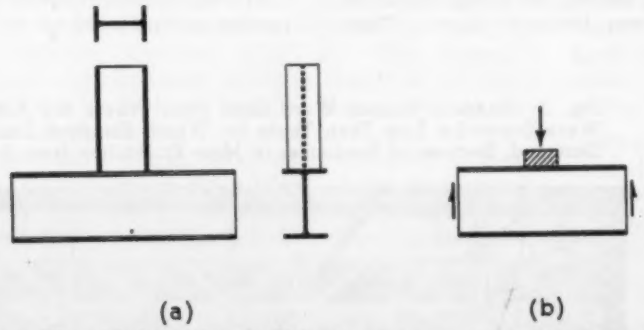


Fig. 5—Tests Were Made on Simple H-Section Joints to Check Buckling Resistance Webs and Flanges

A similar study of the web members also showed these same sections to be the best.

Only one problem remained—the connection at the panel points. Certainly no gusset plates could connect such dissimilar sections as occurred at a joint like Fig. 6, which is a portion of the 80-ft. truss. By rotating each member through 90°, all flanges would be parallel and gusset plates could be used, but in that position the chord would not be nearly as efficient a bending member as if its web were vertical.

The obvious solution was to simply weld the members together, just as they intersected. Such a connection could not be riveted, but was a "natural" for welding. Thus the H-Section Truss was conceived and developed.

This truss was designed to meet one particular set of conditions—as a standard design for the roof trusses of single-story

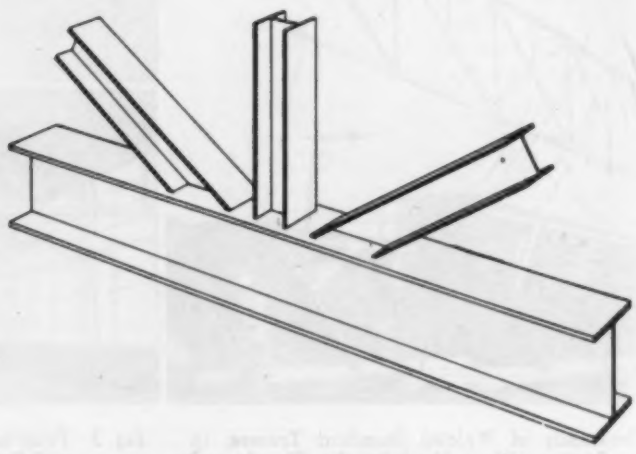


Fig. 6—With the Webs of All Members in the Same Vertical Plane, the Connections Could Not Be Riveted, But Were "Naturals" for Welding

nique permits all welds to be made in the horizontal position.

Note that this fabrication procedure secures the maximum economy inherent in welded structures. There is no punching, coping or chipping; no templates are needed; all welding is the simplest possible—horizontal, fillet welding; and, except for the end connection, every pound of steel is in a truss member—there is no detail material such as gusset plates, fillers or stiffeners.

Program of Tests

After the development of the H-Section Truss design, a search of the engineering literature disclosed no previous trusses of this type. However, a thorough analysis did not reveal any technical disadvantage and the Research Division then secured authorization for a series of tests to positively confirm the design procedure and to provide additional design data.

It is evident that the selection of the individual steel sections to be used for the members of this truss involves not only the section areas and the slenderness ratios of the members, but also a complete analysis of the interaction of the members meeting at each joint, since considerations of web shear and local buckling and crippling often govern the final choice of sections. The primary purpose of the tests was to check these joint analyses.

The first tests were made on the simplest type of H-Section joint: two members welded at right angles with their webs in the same plane (Fig. 5 (*a*)).

Such a joint could be expected to fail by buckling of the webs, but obviously the flanges would participate in the action. The closest analogy of this action in conventional design is the buckling and crippling strength of a beam carrying a concentrated load (Fig. 5 (*b*)). Using this allowable value, as given in the specifications of the American Institute of Steel Construction, a number of such joints were welded and tested at recognized laboratories in Cleveland. Tests were made with both tension and compression in the vertical member and in no case was any buckling apparent at less than four times the allowable load of the above specification.

The question might be asked as to why stiffeners were not placed on the webs of the chords underneath the flanges of the vertical, in the same way that stiffeners are used on a girder under a concentrated load. Two points may be made in answering this.

First, remembering that hundreds of these trusses are to be fabricated, it was found that the additional cost of installing these stiffeners was too great to justify them—if they could be avoided. For one thing, the final welding could no longer be completed in two positions of the truss but would require four positions. Furthermore, there is considerable labor involved in making tight fitting stiffeners to accommodate each individual beam since rolling tolerances permit considerable variation in the dimensions that would have to be met.

Secondly, stiffeners are not necessary for the range of trusses considered because it was found that, with a judicious choice of sections for the chords and web members, all stresses could be kept below those allowed without stiffeners.

After the very encouraging tests of the simple joints it was decided to proceed

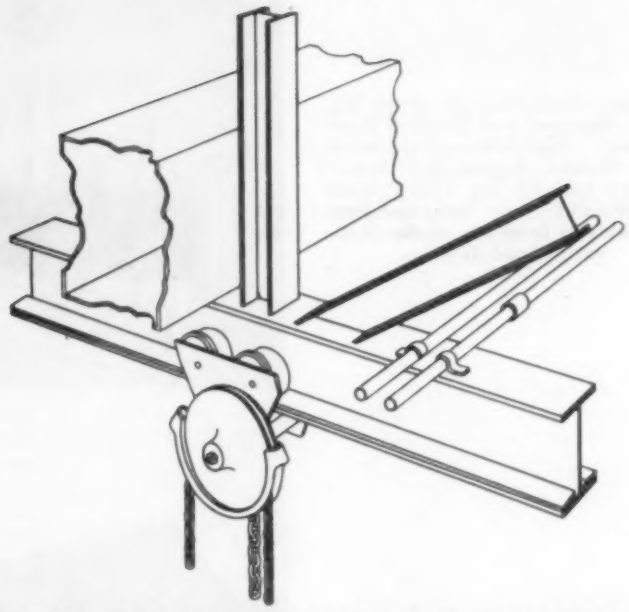


Fig. 7—With a Beam Section for the Bottom Chord, the Top Flange Provides an Ample Seat for Pipes and Ducts, and a Monorail Crane May Be Operated Directly on the Bottom Flange

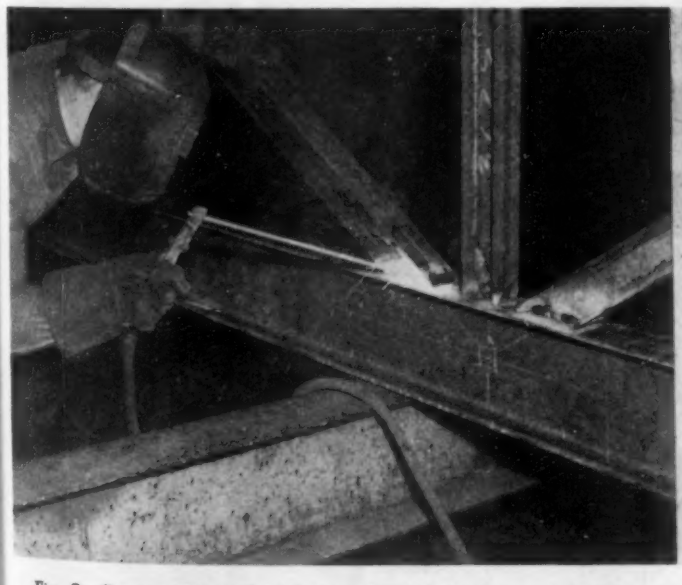


Fig. 8—Since a Fillet Weld Is Run Completely Around All Members at Their End Connections, All Cut Edges Are Covered, and Only the Rolled Surfaces Are Exposed. This Increases Resistance to Corrosion and Simplifies Painting and Maintenance

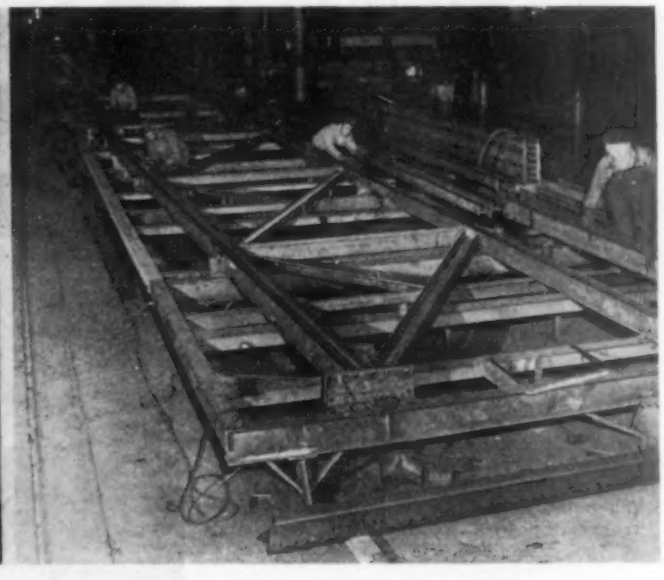


Fig. 9—Assembly of the Truss Members Has Been Reduced to a Simple "Laying in Place" by the Use of Stock Jigs. These Jigs Reduce Production Costs and Insure Accuracy of Assembly So That the Webs of All Members Lie in Precisely the Same Plane

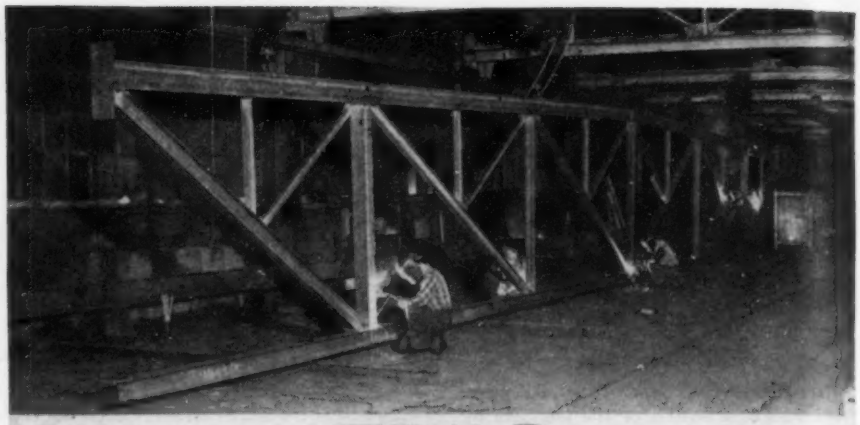


Fig. 10—After Tack Welding in the Jig, Trusses Are Removed and Stood on Their Bottom Chord. After Bottom Chord Joints Have Been Welded, Trusses Are Turned Upside Down and All Top Chord Joints Are Then Welded. This Technique Permits All Welds to Be Made in the Horizontal Position

Fig. 11—Two 50-Ft. H-Section Trusses Were Designed, Fabricated and Tested to Failure. These Trusses Carried a Total Load of 235,400 Lb. Without Apparent Distress in Any Member or Joint, But the Next Increment of 1450 Lb. Caused Failure of One End Vertical

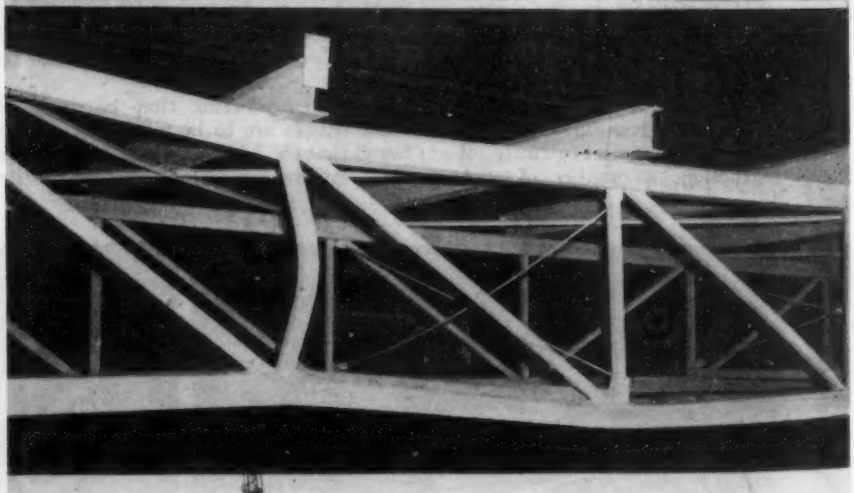


Fig. 12—Throughout the Failure All Welds Held, the Collapse Having Been Caused by Simple Buckling of the End Vertical, Which Was Subjected to More Than Twice Its Allowable Stress

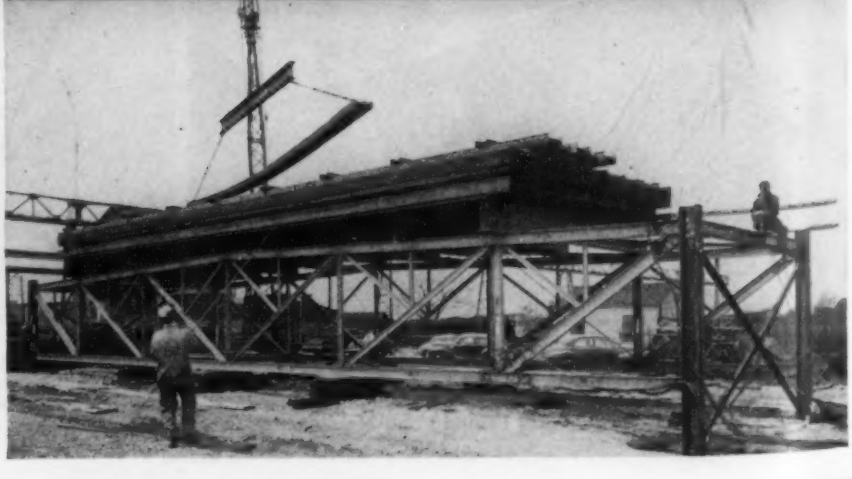


Fig. 13—These 80-Ft. Welded H-Section Trusses Were Loaded to a Total of 254,000 Lb. in Recent Tests Conducted by The Austin Co. to Determine the Flow of Stresses Through Truss Joints of This Type. When the Peak Load Was Removed the Trusses Showed a Maximum Residual Deflection of $1/16$ In.

with the design and fabrication of two 50-ft. H-Section trusses and to test these to failure. This test was made in the yard of the Austin fabricating plant and the load consisted of 60-ft. lengths of rolled steel sections, the increment of load varying from 600 lb. to 2275 lb.

The two trusses carried a total load of 235,400 lb. without apparent distress in any member or joint, but the next increment of 1450 lb. caused the failure of the end vertical of one truss. The load was not removed until the next day and that night further failure occurred at the other end of the same truss. It is interesting to note that despite the terrific impact of the load dropping at failure, the other truss did not fail and after removal of the load was found to have suffered no apparent damage.

Throughout the failure all welds held, the collapse having been caused by simple buckling of the end vertical which was subjected to more than twice its allowable stress.

Based on the observations made at this test, certain minor modifications were made in the design and the H-Section Truss was adopted as the Austin standard for roof trusses. Since then, over 1400 trusses of this type have been fabricated and incorporated in buildings from coast-to-coast having an aggregate floor space of more than a million and a half square feet. These trusses include spans ranging from 50 to 80 ft.

The experience with the H-Section Truss has been so satisfactory that it was felt that some of its principles might be used advantageously in other structural components. Therefore, early this year, authority was secured to make strain gage tests which would provide supplemental data on the stress distribution in the H-Section type of joint. Two series of tests were made: one with two 80-ft. standard trusses and another with a special 18-ft. truss. Staff members of the Case School of Applied Science were retained to conduct and supervise the tests and report on the results.

The first test was conducted in the yard of Austin's Cleveland fabricating plant. Two standard 80-ft. trusses were selected at random from the stock on hand and erected on special columns and foundations provided for this test.

Strain gages were applied principally to the two end joints and to both trusses—in order to provide a check. In all, 144 strain gages were used and their readings were recorded by automatic scanning recorders.

In addition to providing information on the actual strains at the joints being considered, the strain gages removed the necessity for loading the trusses to failure. In view of the current shortage of steel this was highly desirable since the trusses carried over 125 tons of hard-to-replace structural shapes.

In addition to strain gage readings, deflections were measured at each panel point of both trusses and on the four columns. By the use of an engineer's level these were easily read to the nearest sixteenth of an inch.

Two tests were run on the 80-ft. trusses. As in the previous test on the 50-ft. trusses, the load consisted of 60-ft. lengths of steel beams. In the first test, load was applied until a total of 174,000 lb. was reached. This corresponded to approximately 110% of the design load. Deflection and strain gage readings were taken at intervals. Then the applied load was entirely removed.

In the second test, load was applied to a total of 254,000 lb. which represented the equivalent of dead plus twice the design live load. This load remained on the trusses for about an hour during a thorough inspection of all members and joints. No signs of distortion or excessive strain were observed. The unloading was interrupted by a week-end and a total load of 196,000 lb. remained on the truss for more than two days. Then the applied load was finally removed.

Over four thousand strain gage readings were secured and the study of this mass of data has not yet been completed. However, all measured stresses were within the anticipated ranges and the actual action of the truss has been found to be in reasonable conformity with the theoretical.

These trusses again demonstrated the beautiful elasticity of a well proportioned welded structure. This is shown by Table 1, giving the measured deflections at the center of the two trusses during the second test. These values clearly exhibit the complete elastic action of the trusses and a check will show that these deflections are exactly proportional to the applied load. Furthermore, the extremely small residual deflection of $^1/_{15,000}$ of the span is sufficient proof that no yielding due to excessive stress occurred in any part of the trusses, even when loaded to dead plus twice the design load.

Following these tests, further investigations were conducted on a special 18-ft. truss under the 600,000-lb. universal testing machine of the Warner Laboratory at the Case School of Applied Science. This truss was designed for no definite load as the members were selected and disposed to provide certain desired joint configurations. Two of the joints were similar to those on the 80-ft. trusses and were so made to provide a laboratory check of the field tests. One joint was similar to that in a Warren type truss and this joint was so designed that failure would occur at it, in order to provide additional data.

Table 1—Deflections at Center of 80-Ft. H-Section Trusses

Total Load, Pounds	North Truss, Inches	South Truss, Inches
24,000 (dead load)	0	0
174,000	$1^1/_4$	$1^1/_4$
254,000	$1^{15}/_{16}$	$1^{15}/_{16}$
174,000	$1^{15}/_{16}$	$1^{15}/_{16}$
24,000	$^1/_{16}$	$^1/_{16}$

Deflections were measured to nearest sixteenth of an inch.

Again strain readings were taken on about 140 gages, using the automatic scanning recorders. Deflections were read from Ames dials.

This truss was run through three tests, each to successively higher loads and then back to zero. In the fourth test the load was carried to 175,000 lb. when failure occurred by buckling at the Warren type joint.

Another 2000-strain gage readings were secured from this series of tests and these are being studied in connection with the data from the 80-ft. truss tests.

An elaborate series of tests, as have been described, are usually confined to such monumental works as large bridges of extreme proportions, and rarely to so prosaic a structure as a simple roof truss. However, because thousands of these trusses were to be fabricated, this intensive research program was not only feasible but eminently practical. Every engineer is as interested in economy as in adequate strength and welding can prove a valuable tool in securing economical structures. The ever-increasing use of welding in the construction industry is very encouraging to its advocates, and the H-Section Truss is only one example of the developments that may be anticipated as structural engineers continue to explore the opportunities offered by this technique.

Jigs and Fixtures for Automatic Fusion Welding*

By E. D. Morris† and L. J. Berkeley‡

IN THE design of jigs and fixtures for automatic fusion welding particular attention must be paid to several points if the fixtures are to operate satisfactorily and give the desired results. Because of the inherent nature of the welding process, the most important consideration is that the work must be positioned so that the welding progresses in a horizontal or nearly horzontal position. The section to be welded must be held securely in the proper position. Provision must be made to move the workpiece or the welding equipment at the proper welding speed. Also, the fixtures must be designed so that they can be easily loaded and unloaded. Furthermore, if the automatic welding machine is to produce the desired results, all the variable factors that may affect the weld must be controlled and standardized so that the welding conditions are always the same.

In an installation to weld large-diameter heavy-walled pipe, fixtures are usually designed to accommodate a variety of diameters. The material to be welded is usually mounted on trucks provided with rollers so that the section can be rotated for girth welds. The longitudinal welds are usually made by moving the welding head the length of the piece.

Figure 1 shows a typical arrangement for welding relatively thick-walled, large-diameter pipe. The truck and rollers are adjustable for varying diameters. For thick-walled shells, no attempt is made to force the edges of the pipe into contact with the backing bar; instead, the more easily formed copper backing bar is made to conform to any irregularities in the joint. This type of jig is used with either a single- or double-horned fixture.

Double-horned jigs are frequently used in the welding of light-gage material. The copper bar used to back the weld is mounted in the supporting beam. The sheets, being more easily forced into position than the backing bar, are held in firm contact with the backing bar by intermittent copper-faced clamps which are usually actuated by air pressure. By using such a fixture it is not necessary to tack-weld the sections before placing them in the jigs for welding. Proper alignment and spacing of the edges is taken care of by fingers which are built into the jigs.

Figure 2 shows a typical production installation of such a double-horn type of jig. Figure 3 is an enlarged view of the loading end of the jig. The material is 14-gage steel sheet and it comes to the welding machine fully formed. Starting and finishing tabs are inserted automatically as the section is inserted into the fixture. The welding progresses at about 75 in. per minute. This allows a production rate of about 80 units per hour.

When greater production is desired, several types of continuous mills are available for producing these welded sections. Figure 4 shows such a mill for continuous welding of cylindrical sections. These mills can be designed to weld not only cylindrical but also odd shapes such as rectangular or hexagonal sections. This is shown in Fig. 5. The sections to be welded are previously formed and inserted into the mill end to end. They are pulled through the mill by several knurled rollers. At the welding zone, the section is held firmly before and after welding by several pressure rolls or cages. Figure 6 shows a Berkeley continuous longitudinal welder. The cage type units are not widely adjustable and the cage must be made to fit the product. Figure 7 shows the Berkeley mill or larger diameter pipe. As the large heavy sections may not be entirely uniform, it is necessary to use a hydraulic support for the lower cage to prevent binding.

Figures 8 and 9 show a Berkeley continuous longitu-

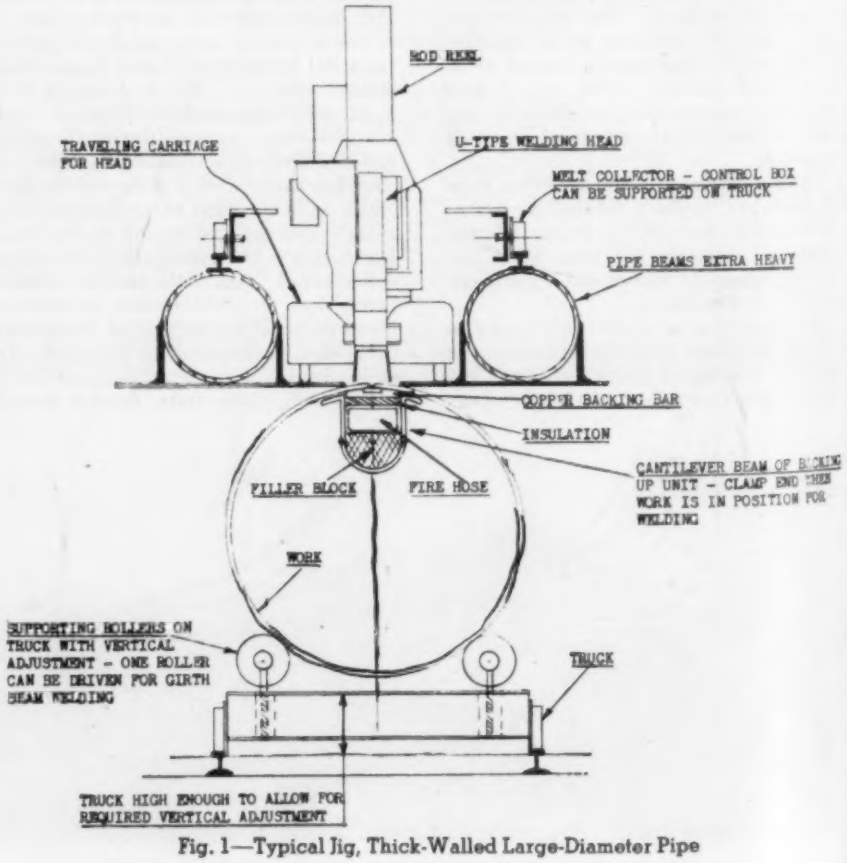

ROD REEL
TRAVELING CARRIAGE FOR HEAD
U-TYPE WELDING HEAD
MELT COLLECTOR - CONTROL BOX CAN BE SUPPORTED ON TRUCK
PIPE BEAMS EXTRA HEAVY
COPPER BACKING BAR
INSULATION
CANTILEVER BEAM OF BACKING UP UNIT - CLAMP END UNDER WORK IS IN POSITION FOR WELDING
FILLER BLOCK
FIRE HOSE
WORK
SUPPORTING ROLLERS ON TRUCK WITH VERTICAL ADJUSTMENT - ONE ROLLER CAN BE DRIVEN FOR GIRTH SEAM WELDING
TRUCK
TRUCK HIGH ENOUGH TO ALLOW FOR REQUIRED VERTICAL ADJUSTMENT

Fig. 1—Typical Jig, Thick-Walled Large-Diameter Pipe

* Presented at Twenty-Seventh Annual Meeting, A.W.S., Atlantic City, N. J., Nov. 17–22, 1946.

† Manager, Unionmelt Service, Central Division, The Linde Air Products Co.

‡ President, Berkeley Equipment Co.

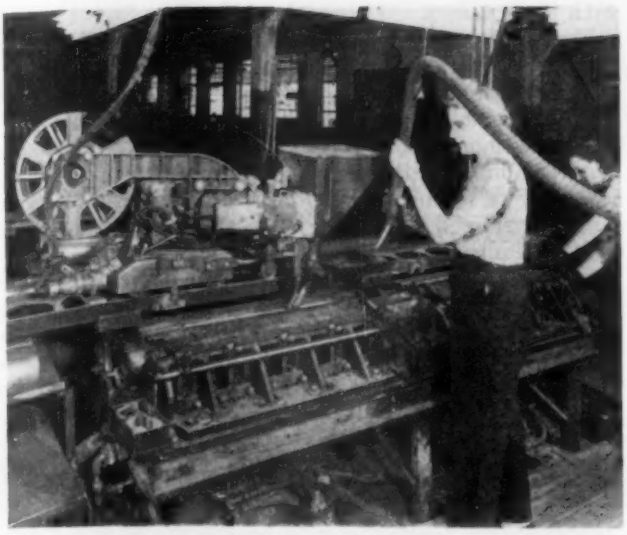


Fig. 2—Typical Production Installations, Double Horned Jig

dinal welding machine, producing shells that are $^3/_8$ in. thick and 32 in. in diameter. Notice that the pressure rolls are supported by hydraulic pistons. The caterpillar type of pressure and traction roll is used because it provides a greater bearing surface with the section to be welded. On continuous mills of this type, the weld is backed by a water-cooled copper shoe supported under the welding zone from the rear by a mandrel.

The assembly of tank ends by circumferential welding is relatively simple. The welding head is stationary and the workpiece is rotated under it. In most instances, an inserted head on backing strip supplies the necessary backing for the welds. Figure 10 shows the girth weld on a large tank end. Small sections can be supported and rotated by the end clamp. The heavier sections are turned by turning rollers.

The turning mechanism must frequently be adaptable to various lengths, diameters and angles of welding. An interesting example of the circumferential weld is shown in the Unionmelt welding of the shock absorber unit for automobiles. Figure 11 shows the operation. Two steel rings are welded to a steel tube by a single weld. The workpiece is supported and turned by an adjustable turning mechanism. The actual welding time is only 16 to 18 sec. per unit. Where certain factors have warranted the cost, a dual welding arrangement has been made so that both ends of a cylindrical shell could be welded into place at the same time.

In the welding of refrigerator compressor housings by the Unionmelt process, it was found necessary to hold the two sections to be welded under relatively high pressure. This was done to prevent the entrance of any

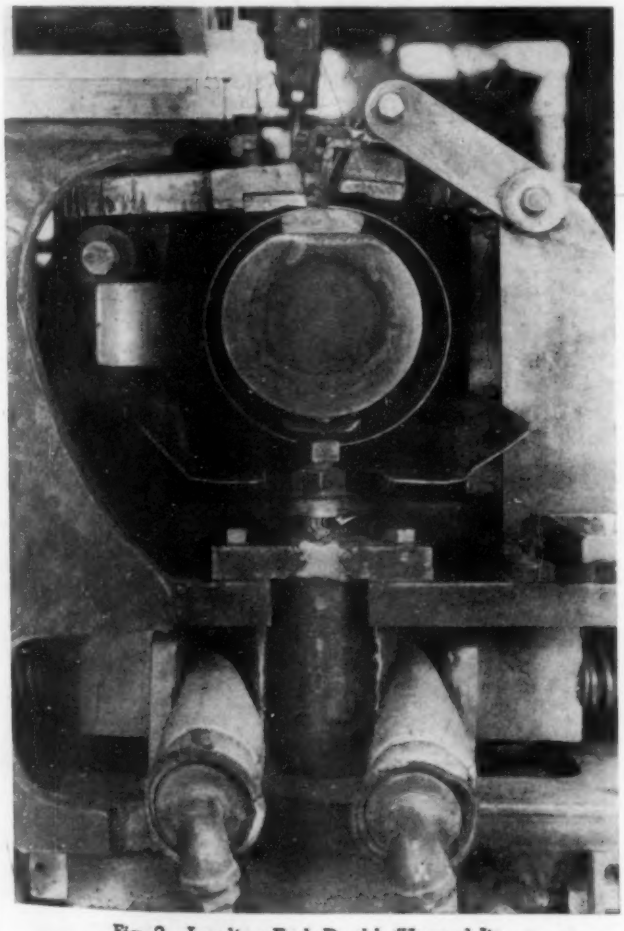


Fig. 3—Loading End, Double Horned Jig

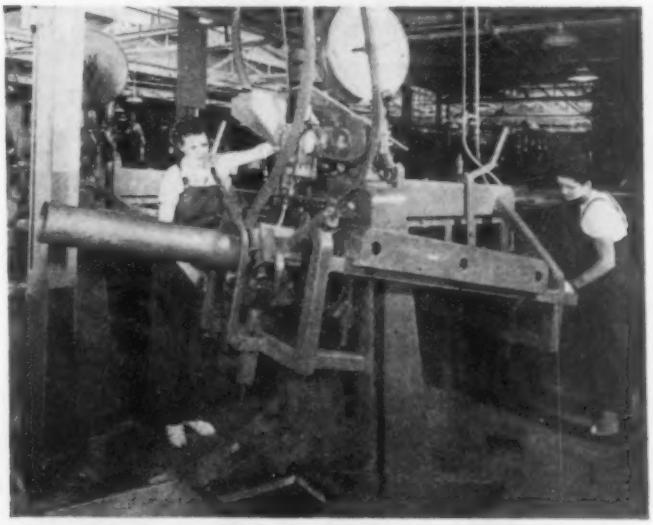


Fig. 4—Continuous Mill for Cylindrical Sections

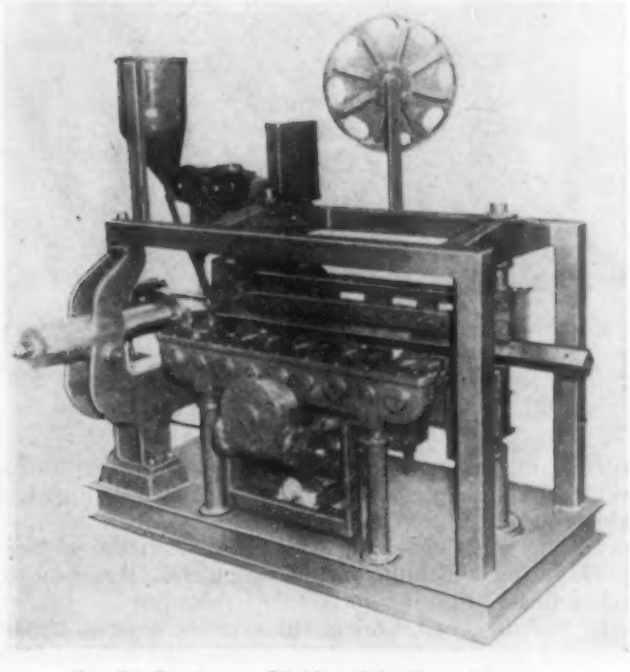


Fig. 5—Continuous Welder, Odd Shaped Sections

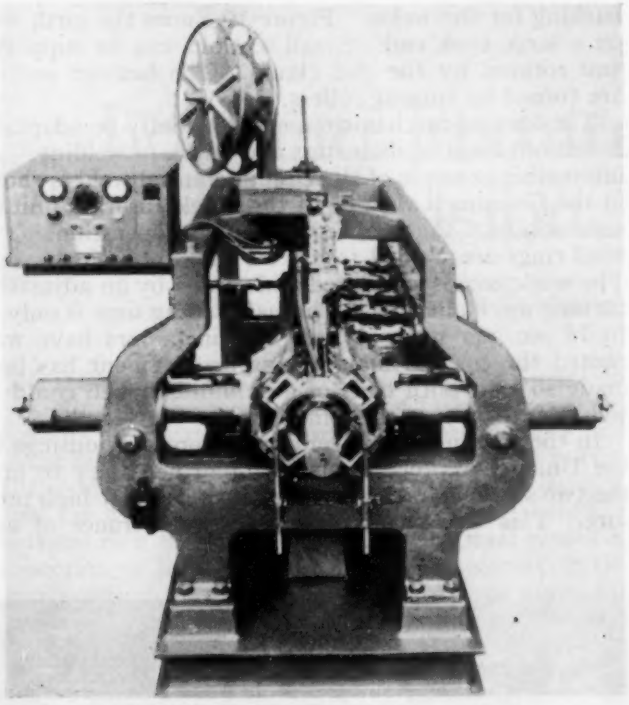


Fig. 6—Berkeley Continuous Welder

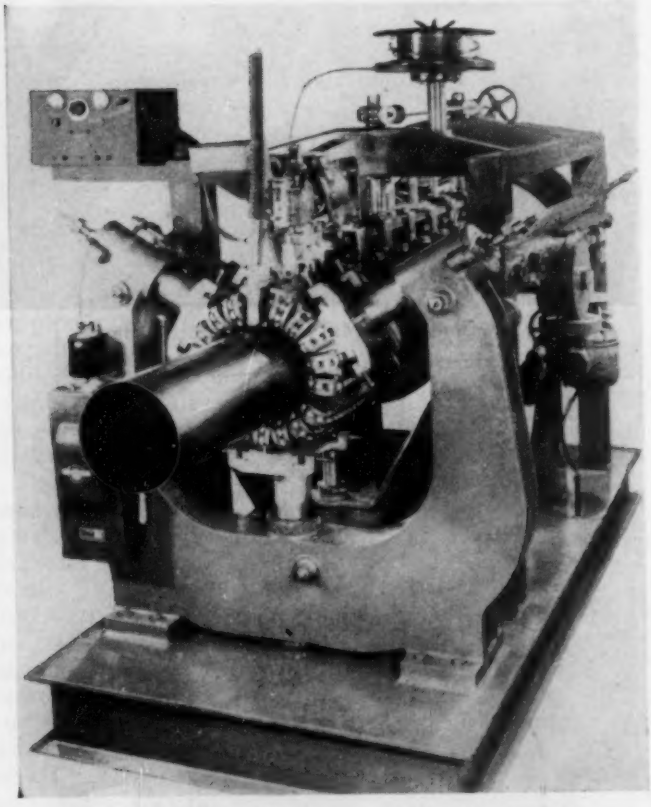


Fig. 7—Berkeley Continuous Welder, Medium Size

foreign material into the compressor housing during welding. A fixture was designed as shown in Fig. 12 in which one end clamp could be driven by a variable speed motor. The other clamp was situated on the end of a quick-acting hydraulic piston which was also mounted in bearings so that it could rotate freely.

In making horizontal circular welds a jig is usually designed to rotate the workpiece under the welding head. An interesting example of such a fixture was designed with three tables. This is shown in Fig. 13. The three tables are mounted on a frame which can be turned around a central support. The tables progress through three positions: loading, welding and unloading. As the table reaches the welding position, a turning mechanism is engaged to rotate the table under the welding head. While welding is progressing at station 2, a new assembly is set up at station 1, and the completed assembly removed at station 3. Such a fixture materially cuts production time.

Figure 14 shows an ingenious cam device to position the welding head in the welding of the manhole reinforcing rings to large tanks. The cam operates an air piston which supports the welding head at the correct distance above the joint as it rotates around the manhole ring.

Another ingenious cam control device is used in the welding of the combustion chambers for the scotch type

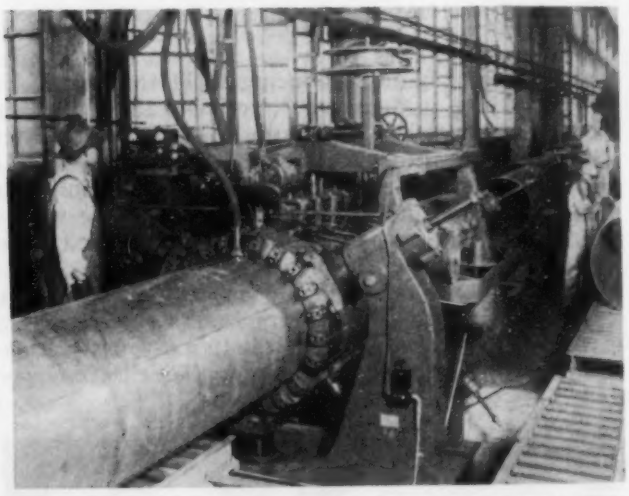


Fig. 8—Berkeley Continuous Welder, Large Size (32 In.)

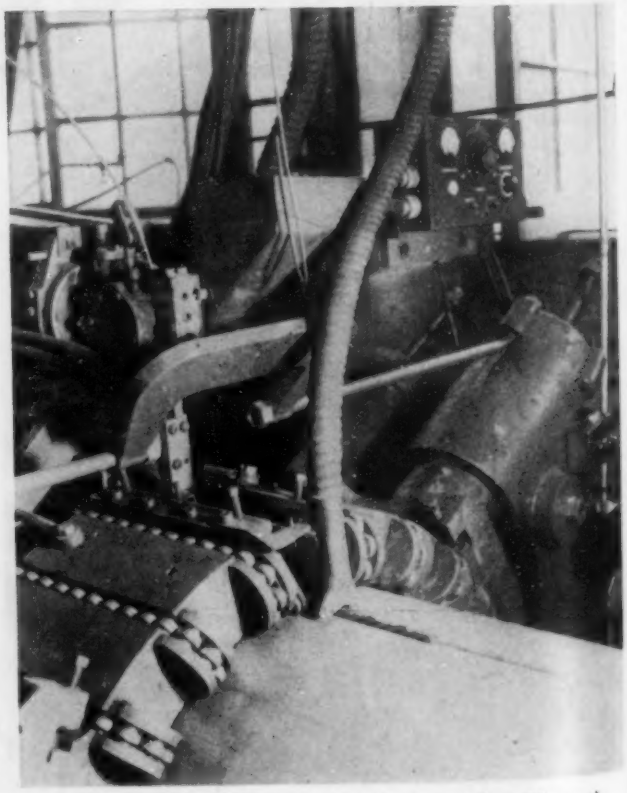


Fig. 9—Berkeley Continuous Welder, Large Size (Closeup)

marine boilers. The welding carriage is driven at constant speed along the surface of the combustion chamber while a cam-controlled leveling device automatically positions the chamber so that the area of weld is always horizontal. This is shown in Fig. 15.

Although strictly not a part of the welding fixtures or jigs, the method of bringing the parts to the welding machines is an important consideration in obtaining high rates of production. Figure 16 shows a conveyor system in a high production installation for the welding of wheels. The sections to be welded are gravity fed to the machines by conveyor. Finished units likewise leave the welding stations by inclined conveyor.

Figure 17 shows the use of an overhead conveyor in an automobile plant for bringing rear axle housings to the

Fig. 10—Girth Weld on Large Tank End

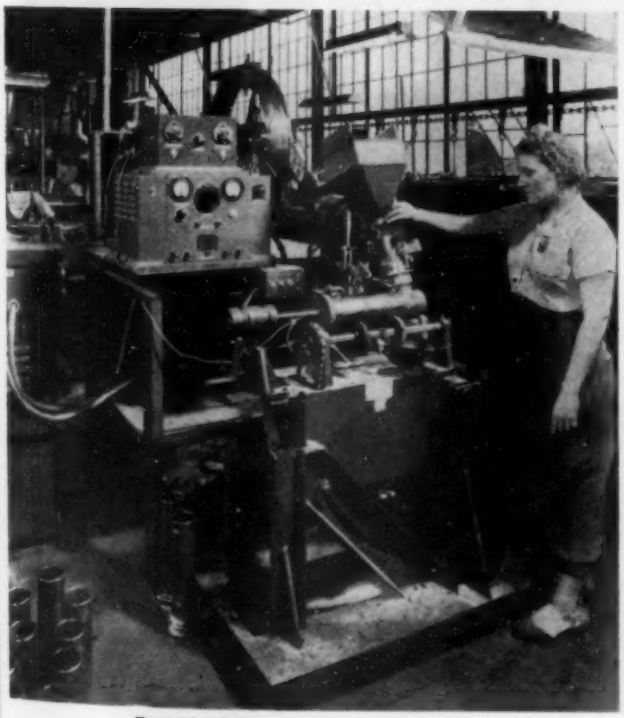


Fig. 11—Welding Shock Absorbers

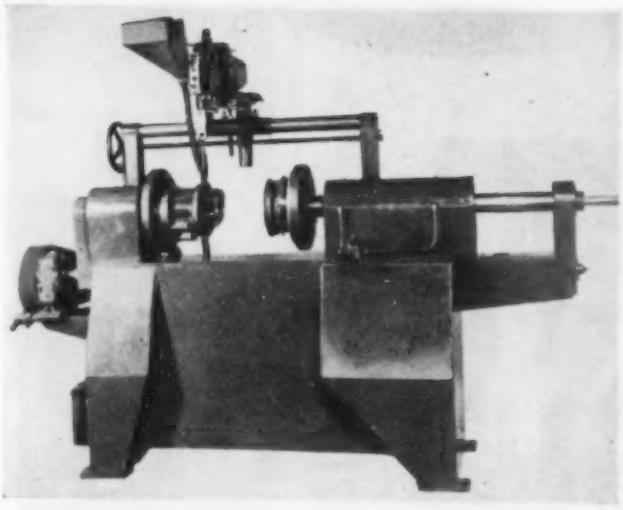


Fig. 12—Welding a Compressor Housing

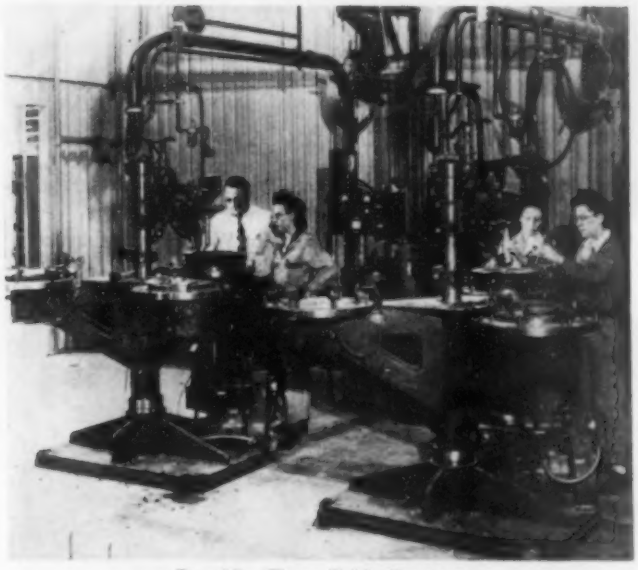


Fig. 13—Three Table Fixture

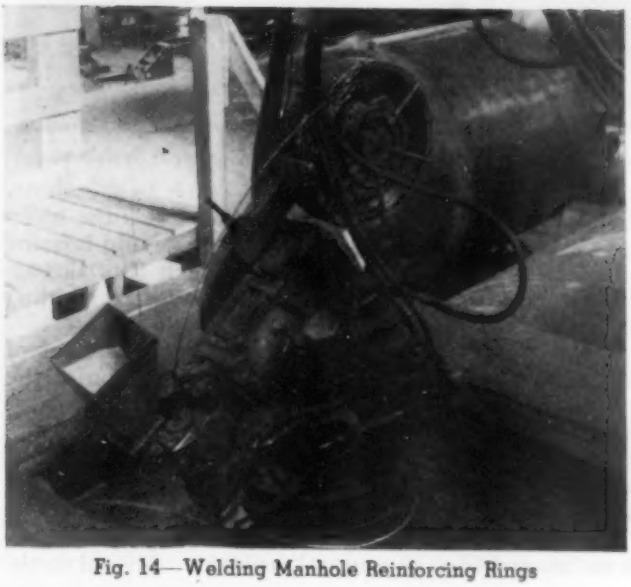


Fig. 14—Welding Manhole Reinforcing Rings

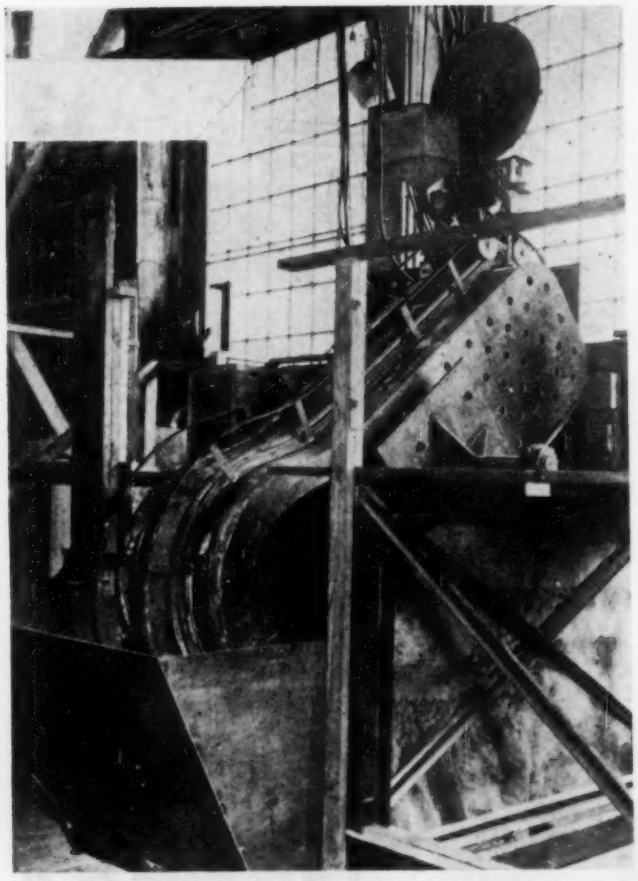


Fig. 15—Automatic Levelling Device for Welding Combustion Chamber

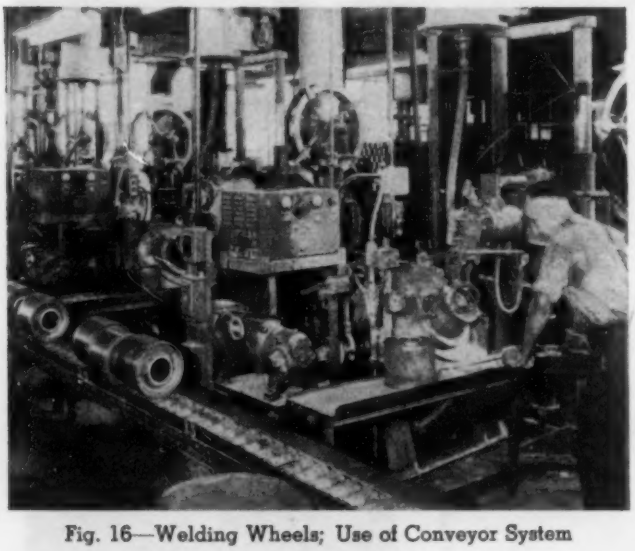


Fig. 16—Welding Wheels; Use of Conveyor System

welding stations. A hydraulic cylinder holds the housing in place during welding. The rear axle and housing are mounted on a positioning unit which tilts the assembly to the proper angle and also rotates it at welding speed under the head.

A totally different type of jig is used in the welding of anchor chains. Figure 18 shows how the region of the weld is contained by a water-cooled copper mold. A stud is inserted under the welding zone and alternate links are closed by welding. The links are tilted 90° and those that remain open are closed by passing through a second machine.

The welding of spiral flights for mine augers or stoker screws has provided an unusual problem. Several methods have been used for solving this problem. One of the most successful is remarkable for its simplicity. The arrangement of equipment is shown in Fig. 19. The spiral is tack-welded into place and the screw turned at proper welding speed in a trough of granular Unionmelt material. The carriage is counterbalanced and moved by guide rolls which rest on the screw flight. Thus the welding head is kept in the correct position at all times. When the weld has been made on one side, the screw is then taken out and reversed and the weld is made on the other side.

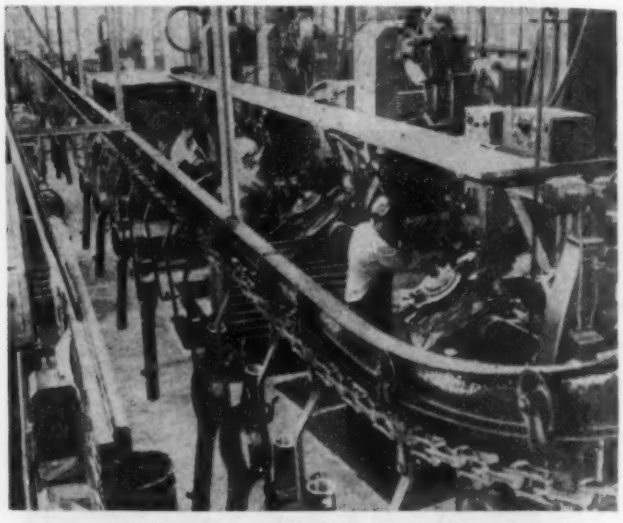


Fig. 17—Welding Automobile Rear Axles, Use of Overhead Conveyor

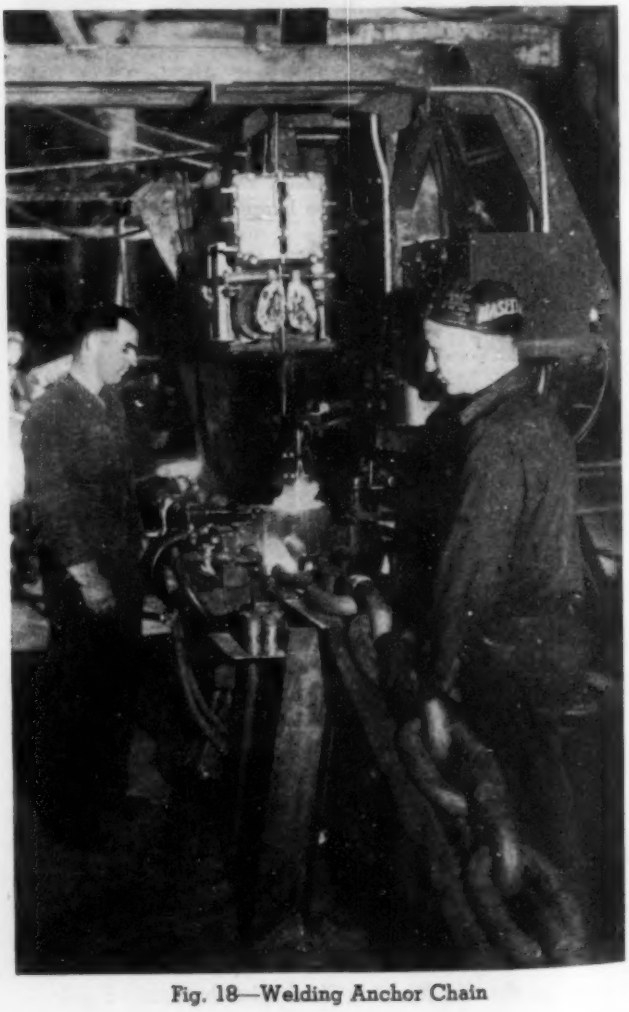


Fig. 18—Welding Anchor Chain

Unusual possibilities are offered in a machine such as shown in Fig. 20. This is a shape welder which will make welds along any desired line. The machine is guided by a shape-following device similar to that used for flame-cutting. With a machine of this type it is also possible to mount another head on the arm and make two identical shape welds at the same time.

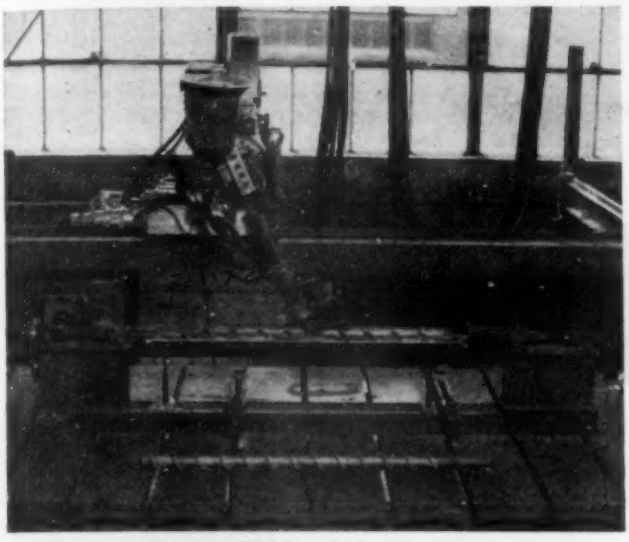


Fig. 19—Welding Stoker Screws

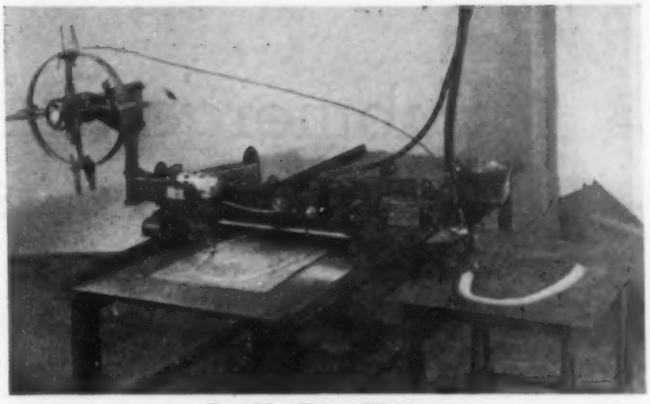


Fig. 20—Shape Welding

It is not the pretension of the authors that the above samples fully cover the field as laid out in the title. It is probably true that there are almost as many pieces of equipment that could be classified as jigs or fixtures as there are users of the submerged melt welding process. The illustrations shown above are representative examples of the way in which this auxiliary equipment makes possible the wide application of the process. To obtain the best results, the jigs and fixtures must be properly designed.

Building Up Locomotive Wheel Centers

By M. J. Conway*

EVEN after locomotive wheel centers have been battered by years of service, they can be restored to their original diameters many times by arc welding so that standard tires can be fitted to them.

Several arc-welding methods have been used successfully for doing this work. Some wheel centers have been built up with deposits made by manual welding with bare or lightly coated electrodes. Some have had steel bands welded to them in order to bring them up to the original diameter. Others have been built up by machine welding with automatic heads, using the flux-shielded or submerged-melt process.

The most economical way, however, is with machine welding using automatic heads feeding bare or lightly coated electrodes, which has been profitably used by several railroad maintenance shops for a number of years. A survey of the various methods which can be used will make the advantages of this method more apparent.

Manual welding with bare or lightly coated electrodes requires changing electrodes many times. This lowers the duty factor and incurs a large amount of electrode stub loss. This method cannot compete economically with machine welding, which feeds coiled electrodes continuously. In manual welding, the material estimate is based on a standard 2-in. stub loss from 14-in. electrodes and a maximum realizable welding duty factor of 60%. The cost with this method amounts to about $44 for material plus 36 man-hours of labor.

Another method is to shrink a band or liner to the rim and weld it in place. A tabulation of costs indicates that it takes 5 hours to turn the wheel center for the new bands; another 5 hours to turn the bands after application; 10 hours to machine the bands before rolling; 1 hour to weld the joints in the bands; 12 hours to bore the bands to fit the wheel centers; and 18 hours to manually weld the bands to the wheel centers. Thus, 51 man-hours of labor are required to build up one pair of wheel centers, plus an electrode cost of about $22.

Machine welding with automatic heads, using the flux-shielded or submerged-melt process, was observed at one maintenance shop. A summary of the cost of this method shows that it takes about 280 lb. of electrode at 7¢ per pound and about an equal amount of granular flux at $4^1/_2$¢ per pound fused, 62 lb. of $^1/_4$- x 1-in. steel bar stock at $3^1/_2$¢ per pound, and 5 lb. of shielded electrodes at $8^1/_2$¢ per pound to weld annular rings to the rims. Labor includes 1 hr. to roll the four rings (exclusive of set-up time for rolls), 1 hr. setup and flux-handling time for wheel centers, 14 hr. machine welding time, 4 hr. to premachine and $6^1/_2$ hr. to finish machine the rims. Thus, the complete cost comes to about $35 for material and $26^1/_4$ man-hours of labor.

With machine welding using automatic heads feeding bare or lightly coated electrodes, a summary of costs would include $^1/_2$ hr. set-up time, 17 hr. of welding, 5 hr. of finish machining, and about 310 lb. of electrode at $8^1/_2$¢ per pound. The complete cost would be about $26.50 for material and $22^1/_2$ man-hours of labor.

* Electric Welding Division, General Electric Co., Schenectady, N. Y.

Submerged Melt Welding of Corrosion-Resistant Metals*

By R. J. Anderson† and H. J. Roberts‡

THE inherent soundness and uniformity of submerged melt welding is possibly of greater advantage in welding corrosion-resistant alloy metals than in lower cost materials because of the values involved. This, coupled with the fact that very close control is obtained of the alloy content of the resultant weld, makes submerged melt welding valuable when it can be applied. It will be the purpose of this paper to discuss some of the problems and report on some of the methods that have been developed in producing satisfactory welds in this class of materials. The effect of heat on certain metals is very similar to the corrosive effect of chemical action. For that reason the scope of this paper will be extended to include the welding of some heat-resistant metals by the submerged melt-welding process.

The problems in connection with the welding of corrosion and heat-resistant metals are both physical and chemical. Due to the annealing action, welds in the copper and nickel alloys may have low tensile strength. Occasionally the welding action alters the chemical resisting characteristics of the metal. This would be manifest by areas which become subject to corrosion while the remaining metal in the adjacent area is not affected. The reasons for the chemical change brought about by the welding action may be due to the loss of alloying elements in the weld metal or the formation of boundaries caused by precipitation of alloying elements.

The granulated welding compositions most commonly used on low-carbon steel are not generally the most satisfactory for alloyed materials. It is possible to choose the granulated material which will maintain the alloy content of the material being welded within satisfactory limits.

In the welding of dissimilar metals such as clad steels, the above problems are all present with the addition of one more—the dilution of the clad surface by the base metal.

While it is usual to choose a welding rod the chemical composition of which approximates the parent metal as closely as possible, it has been found advisable, sometimes, to use a rod that has a higher percentage of certain alloys than the parent metal. This is to allow for those elements that are lost during the welding process. Columbium and chromium are examples of elements so affected. Special formulas of granular welding composition have also been developed to supply alloying elements which may be lost. Special operating procedures have also been developed which give satisfactory results.

A few examples will illustrate the problems encountered and the corrective measures necessary to obtain satisfactory welds of the corrosion-resistant metals.

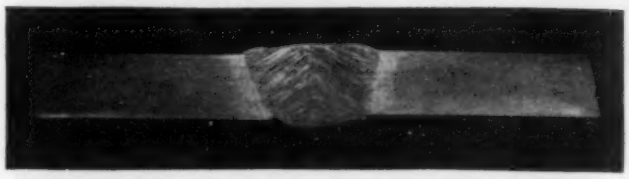


Fig. 1—Weld in $^1/_2$ In. Everdur

Welding Everdur

The following data on welding Everdur, were obtained in the Tonawanda Fabricating Shops of The Linde Air Products Co. One-half inch Everdur was welded at 975 amp., 39 v. and at a speed of 20 in. per minute. The material was prepared with a 60° vee included angle and a $^3/_{16}$-in. unbeveled root face. A cross section of this weld is shown in Fig. 1.

	Yield	Ultimate	Elongation	Reduction (in Area)
Tensile (Longitudinal)	15,390	47,100	70.6	59.0
Tensile (Transverse)	16,300	46,200	49.3	59.0

Everdur 1010 rod $^5/_{16}$ in. in diameter was used with grade H Unionmelt material. In the free bend test with the top of the weld outside, 72% elongation was obtained with no failure. Back of the weld was bent so that an elongation of 84% was obtained with no failure. The

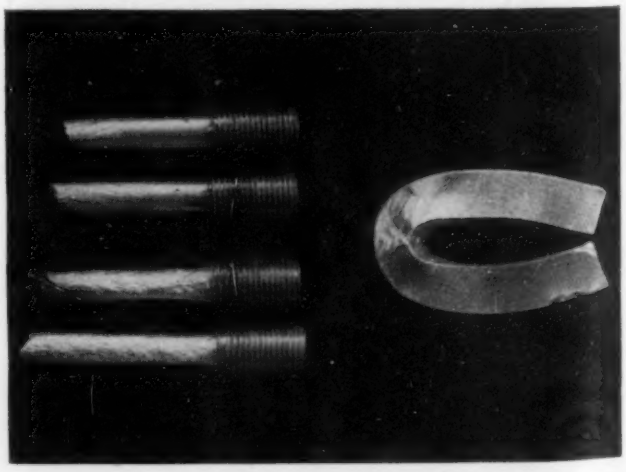


Fig. 2—Test Specimens of Everdur Weld

* Paper presented at Twenty-Seventh Annual Meeting, A.W.S., Atlantic City, N. J., Nov. 17, 1946.

† Manager, Unionmelt Service, Dominion Oxygen Co., Ltd.

‡ Unionmelt Process Engineer, Central Division, The Linde Air Products Co.

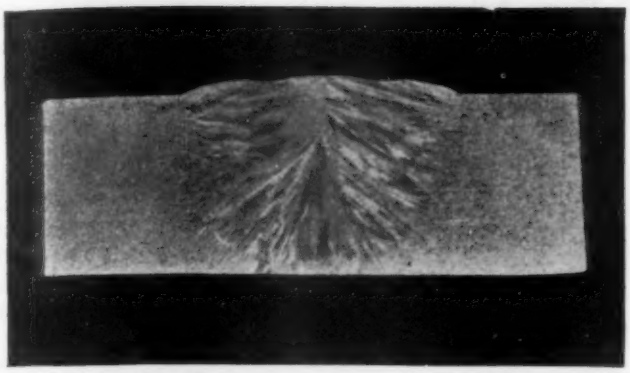


Fig. 3—Macro-Section Everdur Weld

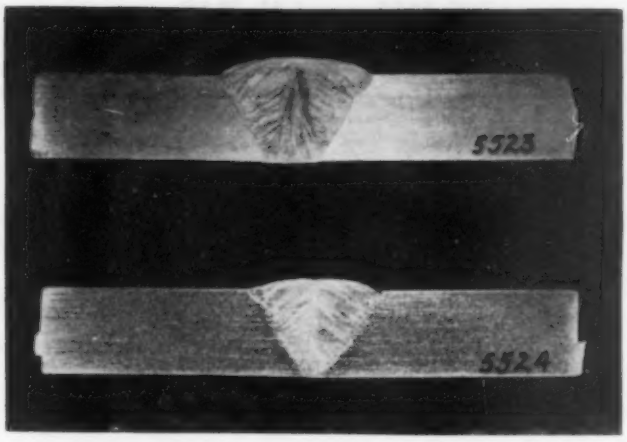


Fig. 5—Macro-Structure of Weld in Monel and Nickel

Fig. 4—Micro-Section Everdur Weld

following table shows the tensile strength of all-weld-metal samples compared with a transverse section across the weld.

Figure 2 shows the nature of the fracture, and the bend test sample. All-weld-metal samples are on the left.

The weld picked up manganese and lost silicon, as shown in the table below. It was extremely ductile. The tensile strength was just under 50,000 psi. It is expected that further developments will give higher tensile strengths by use of a higher silicon content in the welding rod.

	Si	Mn	Fe
Plate	2.71	0.97	0.35
Rod	2.93	0.93	0.50
Weld	2.50	1.21	0.42

The following table of Charpy impact test results shows an increase in impact resistance at low temperatures, and a difference in values which can be expected between cast and wrought Everdur.

Charpy Impact Test

	Room Temperature	−78° C.	−183° C.
Plate	83 ft.-lb.	75.5	74.5
Weld Metal	27.7 ft.-lb.	32.7	31.5

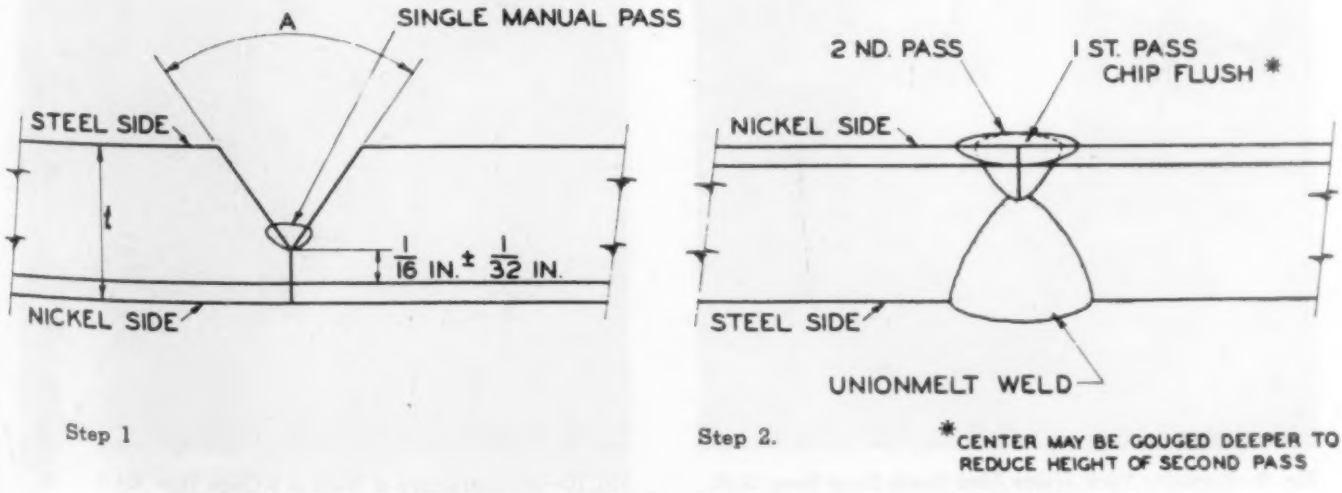


Fig. 6—Method of Welding Clad Steel. No Contamination of Steel by Nickel

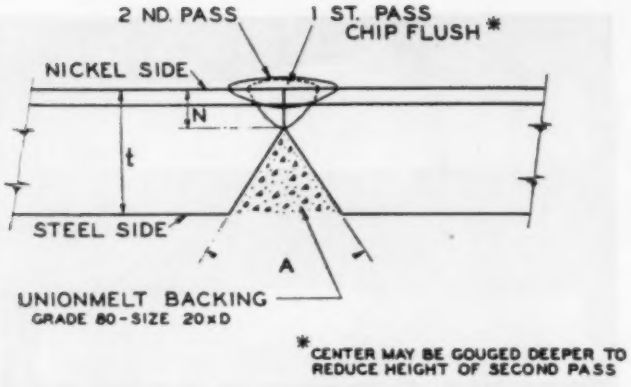


Fig. 7—Method of Welding Clad Steel. Nickel Side Welded First

Fig. 8—Finished Tanks, Nickel Clad. Before Accessories Are Added

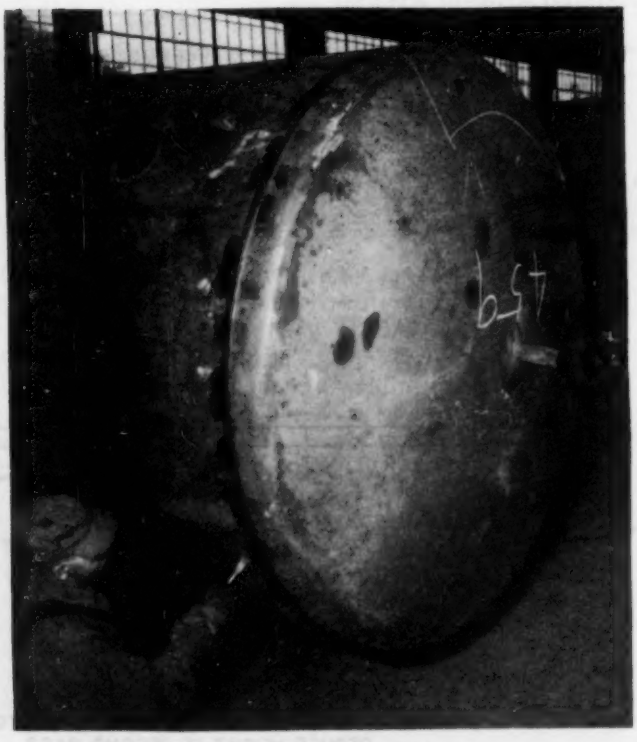


Fig. 9—Removing Tack Welds After Heads Have Been Girth Welded

Figure 3 shows the macrosection of another weld in Everdur. Figure 4 shows a microsection of the same weld.

Welding of Nickel and Monel Metal Plate

Satisfactory welds have been made in nickel and Monel metal plates. Standard plate edge preparation for steel of this thickness was used, i.e., 60° vee with $^3/_{16}$-in. unbevelled root face. The first welds were made with grade 80 Unionmelt material and then additional welds were made with grade 20 material.

The first welds in nickel plate made with both grades of material showed some porosity in X-ray examination, due to failure to penetrate the full thickness. Another weld was made with grade 20 material in the nickel using a deeper 60° vee bevelled down to a $^1/_{16}$-in. nose, and the welding speed was reduced from 18 to 10 in. per minute. This change resulted in a wider weld, more thorough penetration, and almost complete absence of porosity. The macro-structure of the weld is shown in Fig. 5. Specimen No. 5523 shows the weld in Monel metal and No. 5524 the weld in nickel. Tests for tensile strength were made on the Monel and nickel. The all-weld metal Monel tensile test showed that the weld was approximately 80% of the strength of the plate. The nickel weld had about 70% of the strength of the plate.

For the impact test at low temperature the Charpy values were taken at room temperature, −78° C., and −183° C. There was practically no change in the impact resistance of the Monel samples. The Charpy values were from 40 to 50 ft.-lb. or about one-half the values for the plate. In the case of the nickel weld two of the specimens gave low values at −183° C. The

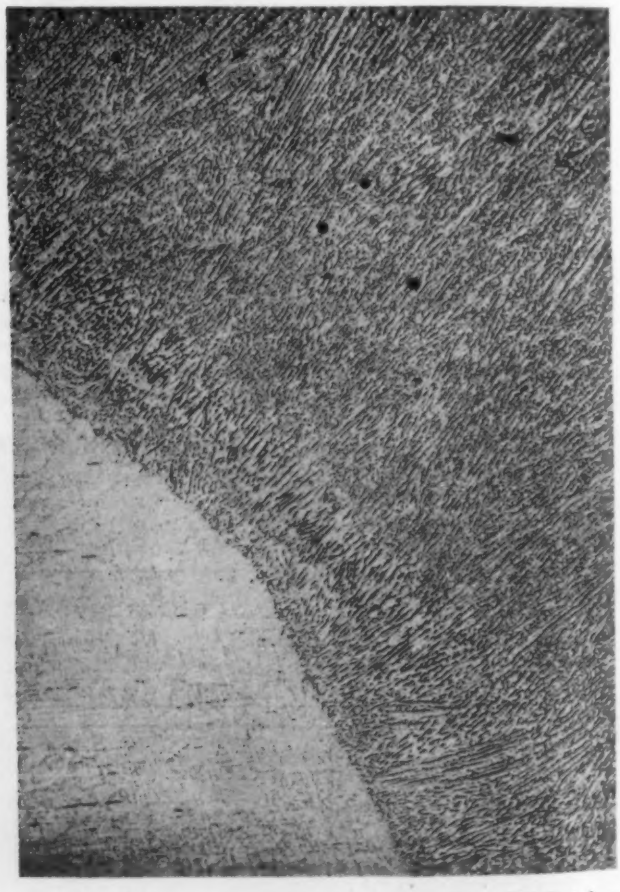


Fig. 10—Microstructure of Weld in 9 Gage Type 304 Stainless Steel

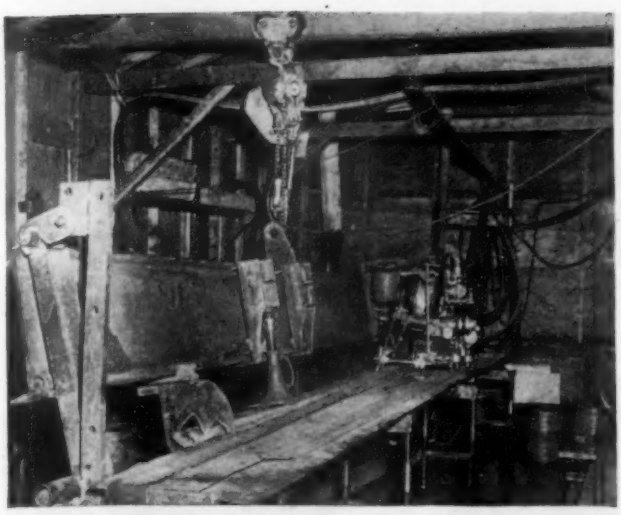


Fig. 11—Welding Stainless Steel Tracks

low value specimens showed pronounced columnar structure and fracture along the center freezing line. Heat treatment or the use of an alloyed nickel rod (possibly with manganese) would probably improve the impact values of nickel welds at −183° C.

Welding of Nickel-Clad Steel

In the welding of nickel-clad steel, either of two methods may be used. One method, Fig. 6, insures freedom from contamination of the steel weld by the nickel. A manual bead is first laid down in the vee. A submerged melt pass is then made on the steel side penetrating into the hand pass. A submerged melt weld is then made on the nickel side with nickel rod, the bead is chipped flush and a second bead laid down. In this manner the contamination of the nickel deposit is readily limited to less than 15% iron. In the other method shown in Fig. 7, the weld is first made on the nickel surface with nickel rod. The second bead is laid down on top of the first and then the main part of the weld made by the submerged-melt method on the steel side.

Special welding techniques were necessary in the submerged melt welding of nickel-clad steel for tank cars. The tanks were fabricated from $^3/_8$-in and $^1/_2$-in. steel clad with a 0.025-in. nickel surface. All bevels were made by machining. The root faces were butted together tightly and strips tacked across the vee to hold the plates in place. A manual bead was laid down in the vee and a single-pass submerged melt weld was made at 540 amp. on the steel side. The nickel side was then gouged out about $^1/_{16}$-in. and a nickel deposit made by a manual arc weld. The finished tanks are shown in Fig. 8 before accessories are added. The tack welds are chipped off after the heads have been welded in place. The tanks are 32 ft. long and 76 in. I.D., with a capacity of 10,000 gallons.

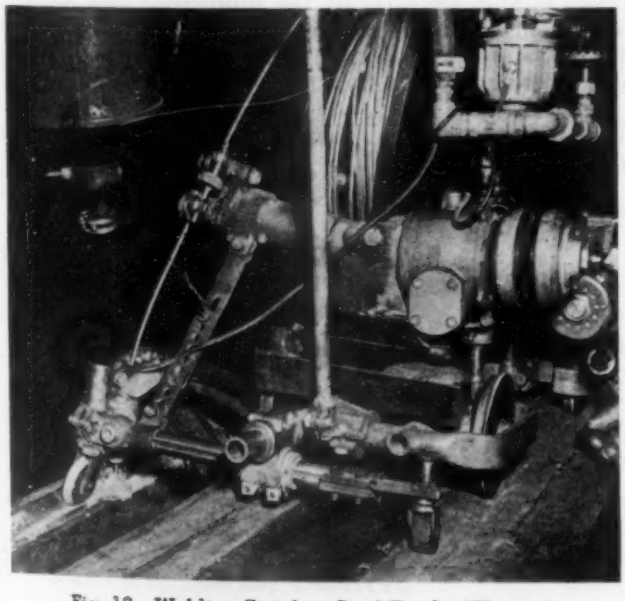


Fig. 12—Welding Stainless Steel Tracks (Closeup)

Welding of the Stainless Alloys

The widest use of submerged melt welding applied to corrosion resistant alloys is on the types of 18–8 stainless steel. As an example, welds have been made in $^3/_4$-in. columbium-bearing, 18–8 chromium nickel plate. The angle of the vee was 45°, a welding of current of 900 amp. at 40 v., and welding speed of 12.5 in. per minute. The finished weld showed good penetration with a reinforcement of about $^3/_{32}$ in. There was practically no loss of columbium during the welding. The nitrogen content

Fig. 13—Stainless Steel Refrigerator Car

corresponded to the usual amount found in these alloys and indicates complete protection of molten metal. Figure 9 shows the microstructure of similar welds made in 9 gage, type 304 stainless steel. In the tensile strength test, a yield point of 40,000 was found and the ultimate strength was determined to be 76,450. The corrosion tests indicated that the weld corrosion rate is essentially that of the base metal.

The welding of stainless steel presents no particular problem, except that in type 347 stainless steel sheets, less than $^1/_8$ in. thick, cross cracking is likely to be encountered. A fabricator in the State of Washington has a simple installation for welding this material. This firm was fabricating stainless steel track for the elevators of aircraft carriers during the war. The track was made by joining a flat strip to a tee bar at one end of the cross bar of the tee. The sections of stainless steel were joined by a positioned fillet weld and a corner weld. Figure 10 shows the arrangement for welding the tracks. The inside fillet weld is being made. Figure 11 shows a closeup view of the outside corner weld being made.

A sample stainless steel refrigerator car has been recently completed. The sides of this car are made of 18-gage, type 304 stainless steel. Type 316, welding rod $^1/_8$ in. diam. was used. The welding current was 325 amp., direct current, reverse polarity at 25 v., and welds were made at speeds of 60 and 90 in. per minute. The 18-gage stainless steel sheets were supplied in sections 4 ft. wide. The sheets were first joined by square butt welds. Then welds were made through the sheets into

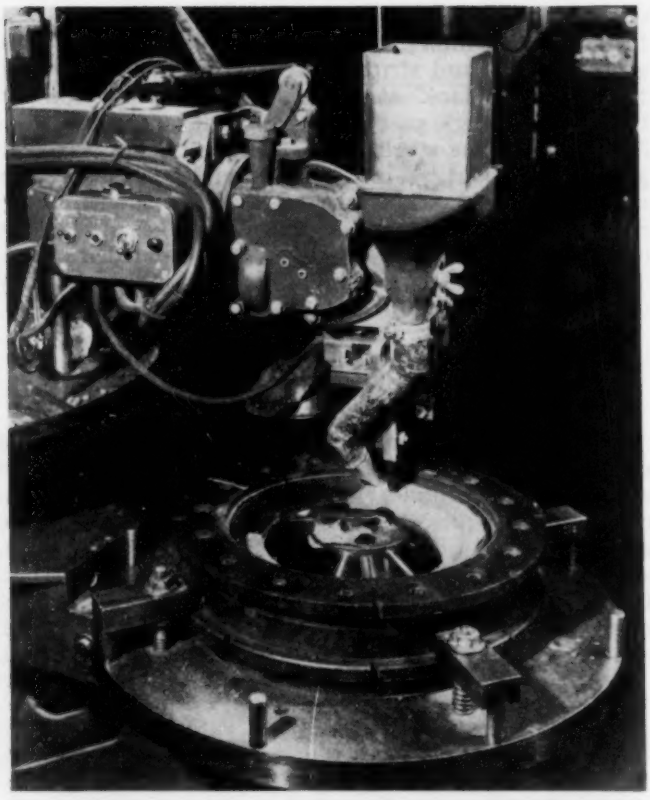


Fig. 14—Welding Supercharger Buckets to Wheel

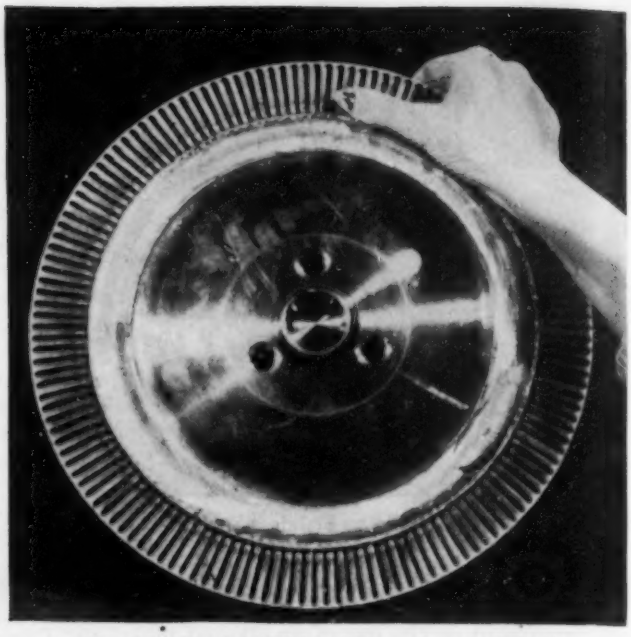


Fig. 15—Finished Weld of Supercharger Wheel

1/4-in. thick mild steel vertical posts on 24-in. centers. Horizontal fillet welds attaching the stainless steel sheet to both the top and bottom sills as well as a vertical fillet weld on each corner sill were then made. The completed car is shown in Fig. 12.

The hand welding of 4–6% chromium steel usually requires that the parts be preheated and maintained above 300° F. during welding. It has been found that this alloy may be welded with the submerged melt process without preheating and even though preheat is used as a precautionary measure, the fact that the welding can be completed so quickly and without subjecting the welder to undesirable working conditions, makes it very advantageous to use this welding process. Plate preparation and welding conditions are practically the same as those used in welding mild steel.

In the welding of the heat-resistant alloys the best known is the welding of gas turbine wheels. The buckets of the wheels, made of Multimet Alloy or Stellite Alloys Nos. 21 or 30, are welded to the center hubs usually of 19–9 DL or Timkin Alloy by a double vee weld made in one pass from each side. A special fixture is necessary for clamping these buckets in position during assembly preheating and welding. Figure 13 shows the assembly being welded in the fixture. Figure 14 shows the completed weld. The weld on the reverse side is the same as the one shown in the picture.

It has been found that the surface of chrome alloy rods for submerged melt welding should be clean and bright so there will be a minimum of heating when the rod picks up the welding current. The distance from the end of the contact jaws to the welding zone should be a minimum so the rod will not heat when it is carrying the full welding current. Heating of the rod causes the weld to change from its normal contour to a narrower top with a loss of penetration. Due to the high heat and current conductivity of copper and nickel base alloys, the surface of such rods need not be so carefully specified.

In conclusion, it may be stated that the welding of corrosion and heat-resisting metals can be satisfactorily performed by the submerged melt process. The stainless steels can usually be welded by using a rod having the same or slightly higher composition of chromium. There are numerous applications of welding of thin sheets of stainless steel by the submerged melt welding process in the manufacture of containers used by the dairy and food processing industries. Nickel, Monel and Everdur require welding rods of the same general type as the base metal, and special techniques are sometimes necessary in order to meet the specifications for the product.

Can you answer these questions about WELDING CAST IRON?

A TWO-MINUTE QUIZ OF INTEREST TO EVERY WELDER

Q. Is it harder to weld cast iron than steel or other metals?

A. Cast iron frequently proves more difficult to weld than other common metals. This is because of cast iron's tendency to change its structure under high heat.

Q. What is the effect of welding heat on cast iron?

A. Some of cast iron's useful properties depend on a proper balance between graphitic and combined carbon. When cast iron is reheated to the molten state, as in welding, some of the graphitic carbon recombines with iron to form combined carbon. Unless the iron cools gradually, the carbides thus formed remain as combined carbon. An excessive amount of combined carbon in cast iron makes the iron hard and extremely difficult to machine.

Q. How can this tendency be eliminated?

A. First, by avoiding excessive heat in the welding zone. Second, by obtaining a slow rate of cooling. Third, by choosing the right welding material.

Q. What is the best method of welding cast iron?

A. All have their advantages. For years, oxy-acetylene was the favorite. Now, however, because of recent improvements in electrode composition, the metal-arc method is coming rapidly to the fore.

Q. What are these improvements in electrode composition?

A. Research on electrodes for welding cast iron has centered around achieving strong, machinable welds, free from cracks and porosity. At INCO this has meant the careful study of the materials used for core wire and flux coatings in the development of the NI-ROD* electrode.

Q. Does NI-ROD provide sound, strong, welds?

A. Extensive use has proved the soundness of NI-ROD welds. NI-ROD's slag does an excellent job of scavenging gas from the weld metal, assuring deposits of maximum strength and freedom from porosity.

Q. Is preheating necessary with NI-ROD?

A. NI-ROD flows so well and "washes" so evenly against the sides of the joint that it is usually unnecessary to preheat the joint. However, hard-and-fast rules cannot be formulated to cover all conditions. Preheating to 300-400°F is useful on many jobs to reduce stresses or provide the highest degree of machinability.

Q. Are NI-ROD welds easily machinable?

A. Yes, NI-ROD's deposit and weld zone are easily machinable. The deposit is nickel, a metal which doesn't lose its machining characteristics under rapid temperature changes. The fusion zone retains its machinability because NI-ROD's smooth arcing and flow characteristics keep the heating-quenching cycle to a minimum.

•

NI-ROD comes in $\frac{3}{32}$", $\frac{1}{8}$", $\frac{5}{32}$" and $\frac{3}{16}$" diameters. Order a 5-lb. package and you'll agree it's the ideal answer to any cast iron welding problem where strong, sound, machinable joints are required.

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ACTIVITIES — RELATED EVENTS

INCO DEVELOPMENT AND RESEARCH DIVISION PROMOTIONS

Dr. William A. Mudge has been appointed Director of the Technical Service Section of the Development and Research Division of The International Nickel Co., Inc., and William F. Burchfield, Assistant Director, T. H. Wickenden, Manager of the Division, announced. Formerly Assistant Director, Dr. Mudge succeeds O. B. J. Fraser, who recently was made Assistant Manager of the Development and Research Division.

Donald J. Reese, while continuing to head the Iron and Non-Ferrous Casting Section of the Division, will also be in charge of its Field Sections. The latter position was formerly under the direction of H. J. French, who was recently appointed Assistant Vice-President of International Nickel.

Mr. Wickenden also announced that the various units of the Division's Steel Section are now headed by the following: J. W. Sands, Engineering Steels; Dr. V. N. Krivobok, Stainless Steels; and T. N. Armstrong, Jr., Railway and Cast Steels.

Mr. Burchfield has been in the employ of the present INCO organization and a predecessor company since 1925 and has been associated with the Development and Research Division for over 18 yr. He is on several committees of the American Society of Mechanical Engineers and is a member of the Institute of Aeronautical Engineering, Society of Automotive Engineers, American Society for Metals and AMERICAN WELDING SOCIETY.

PUBLIC HEARINGS PLANNED FOR HOUSTON, TEX., AND LOS ANGELES, CALIF., BY THE A.S.M.E. BOILER CODE COMMITTEE ON THE RECENTLY RELEASED DRAFT OF THE PROPOSED REVISION OF SECTION VIII

A previous announcement has already been made by the Boiler Code Committee of The American Society of Mechanical Engineers that its Special Committee to Revise Section VIII of the A.S.M.E. Boiler Construction Code (Unfired Pressure Vessel Code) has submitted in draft form the Proposed Revision of Section VIII of the Code, dated January 1947.

The Boiler Code Committee has made arrangements to hold two public hearings in the Southwest on the proposed revision. The first of these hearings will be held in Houston, Tex., at the Rice Hotel, on May 1st at 8:00 P.M. and on May 2nd at 9:30 A.M. The second hearing will be held in Los Angeles, Calif., at the Biltmore Hotel, on May 7th at 9:30 A.M. The purpose of these hearings is to give all those interested in the Code, such as pressure vessel manufacturers, users and state enforcement authorities, an opportunity to express verbally their comments on the proposed revision.

The public hearing in Houston will be under the sponsorship of the A.S.M.E. South Texas Section, and the one in Los Angeles under that of the Southern California Section. Members of the Boiler Code Committee and its subcommittees are planning to travel in a group to attend these hearings.

The Boiler Code Committee will also hold its May meeting at the Biltmore Hotel in Los Angeles on Friday, May 9th.

The Boiler Code Committee is particularly desirous of attracting to these meetings all users of the A.S.M.E. Unfired Pressure Vessel Code, such as pressure vessel manufacturers and users, representatives from the petroleum industry, state officials and any others who have an interest in the Code.

For those interested in reviewing the proposed revision, copies are obtainable from the A.S.M.E. at 29 W. 39th St., New York 18, N. Y., at $1.00 per copy. All those interested are invited to submit their comments in writing to the Secretary of the Boiler Code Committee, whether or not they are able to attend one of these hearings.

The National Board of Boiler and Pressure Vessel Inspectors is also holding its General Meeting on May 5th, 6th and 8th at the Biltmore Hotel in Los Angeles. Their members, who constitute the Conference Committee of the Boiler Code Committee, will also attend the hearings and the Committee meeting.

WELDING SYMPOSIUM IN HOLLAND

A welding symposium is to be held in Utrecht, Holland, June 4–5, 1947. So far the schedule calls for two papers on hard facing and four papers on welding in boiler and apparatus construction. The latter papers are:

1. "A Review of Boiler Welding Requirements Relating Factor of Safety to Weld Re-enforcement," by P. Bongers.
2. "A Discussion of Stress Relief Heat Treatment, Positioners, and the Welding of Locomotive Boilers," by P. Capel.
3. "A Paper on the Corrosion Resistance of Welded Joints in the Chemical Industry, Especially American Grades of 18–8," by B. Goedhuis.
4. "A Discussion of the Welding Specifications of API-ASME for the Oil Industry," by W. P. Kerkhof.

ENGINEERING AND MARINE EXHIBITION

The Engineering and Marine Exhibition (28 Aug.–13 Sept. 1947) will be held in London's largest exhibition building, Olympia, and will be the first of the series held since 1937. Ten years' astounding progress in Britain's engineering industry will be shown. Copies of the announcement will be sent gladly on request. The British Engineers' Association 32, Victoria St., London, S.W.1.

PREDOCTORAL RESEARCH FELLOWSHIPS AND POSTDOCTORAL RESEARCH ASSOCIATESHIPS

For the year beginning in the summer or fall of 1947, Battelle Memorial Institute will appoint a limited number of predoctoral Fellows and postdoctoral Associates to conduct investigations of a fundamental character in the Battelle laboratories. This is a part of a training program which has been in operation at Battelle since 1931.

Fellows and Associates are brought together for a year's "interneship" at Battelle for the purpose of training research men, primarily for careers in industrial research. Appointees devote their full time to their own research projects in the Battelle laboratories under the guidance of the Battelle technical staff. The projects must be of a fundamental or general nature, leading to the discovery of scientific principles or the gathering of significant new data. The findings are to be prepared for publication as a service to science and industry.

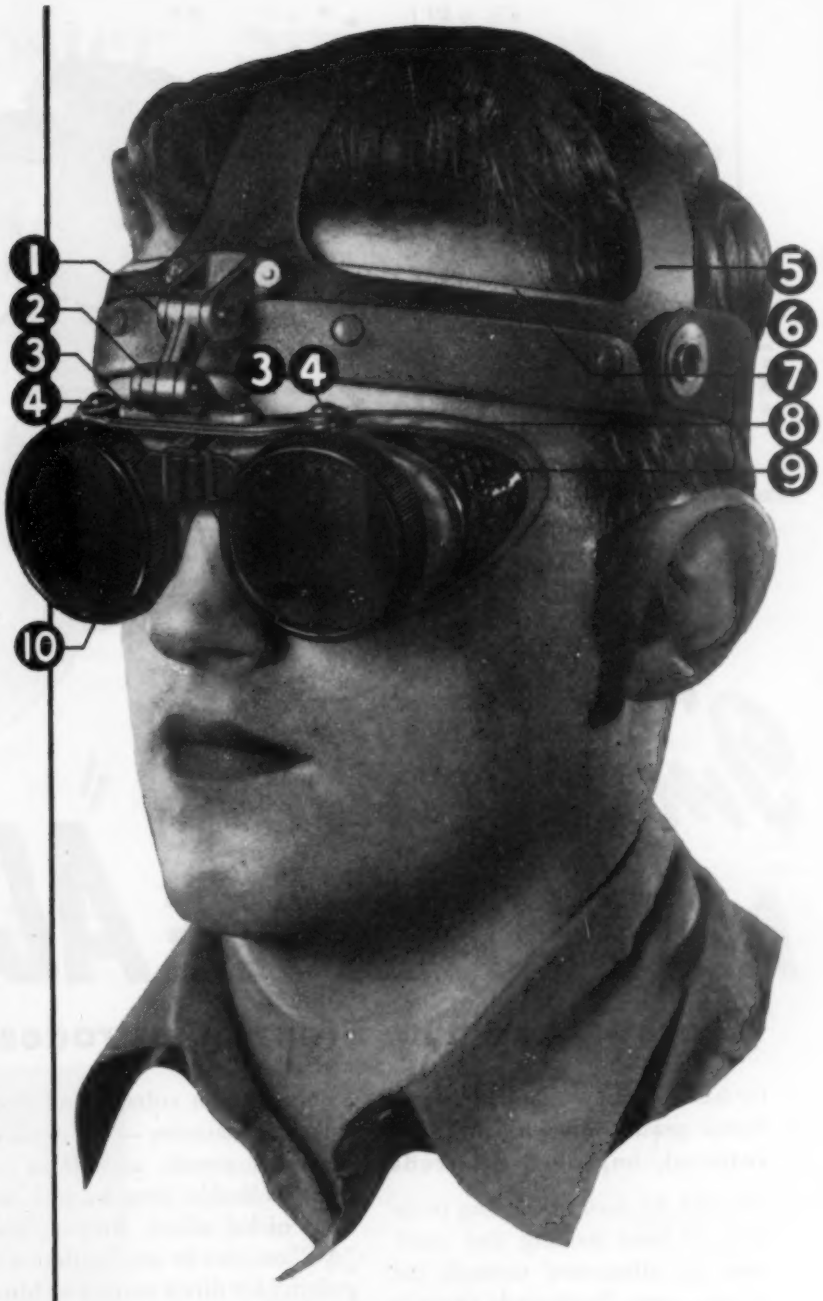
Fellowships are open to men seeking the Doctor's degree in a science or in engineering, and are available normally for the final year of graduate study. After com-

(*Continued on page 348*)

NEW

A-O Head-Rest Goggles

FOR PEAK EFFICIENCY WITH COMFORT



1 "OFF-GUARD" ADJUSTMENT
With one hand, welder can instantly throw goggle into "off-guard" position, where it is held securely by friction joint. Complete ventilation obtained each time goggle is raised.

2 FACIAL ADJUSTMENT
Positive friction joint enables goggle to be adjusted quickly to facial contour, and held firmly in place.

3 PD ADJUSTMENT
Nut and bolt assembly allows adjustment to proper pupillary distance. This adjustment is made only once for each individual.

4 SIDE ADJUSTMENT
Simple side adjustment enables wearer to fit eyecups flush against face to prevent any light leakage.

5 HEADGEAR
Comfortable headgear assembly of fibre construction fits snugly and distributes weight of goggle over entire head.

6 HEADGEAR ADJUSTMENT
Back headband is adjusted by knurled nut turning on right and left hand threaded stud. Headband slides within a fibre sleeve in back, permitting easy adjustment to varying head sizes, and preventing hair pulling.

7 SWEATBAND
Genuine leather sweatband affords additional comfort.

8 EYECUPS
Opaque eyecups are specially designed for wear directly over eyes or over personal prescription glasses.

9 SIDE SHIELDS
Indirect, ventilated side shields keep out stray light rays, sparks and metal splashes, yet provide ventilation to reduce fogging.

10 LENSES
Available with Noviweld lenses in shades 3, 4, 5, 6 or 8. May also be obtained with Noviweld-Didymium lenses in shades 3, 4, 5 or 6. Easily replaceable cover lenses protect filter lenses from pitting or scratching.

Send to your nearest A-O Safety Representative for complete information on this new A-O development.

American Optical
COMPANY
Safety Division

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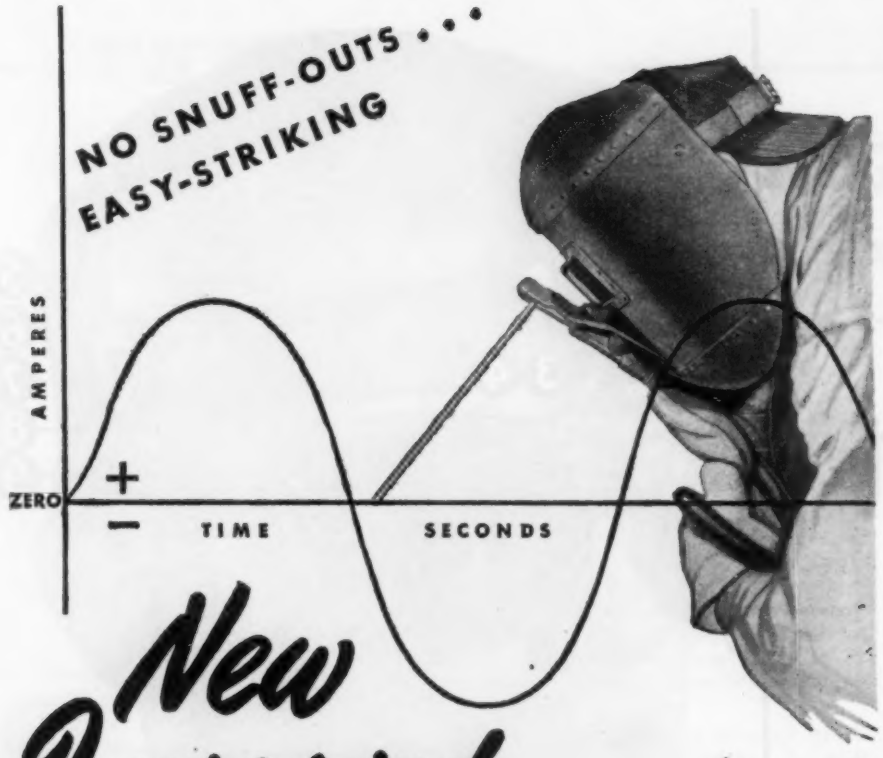
BRANCHES IN PRINCIPAL INDUSTRIAL CITIES



New Improved AMPCO-TRODE "AC"

Coated Aluminum Bronze Electrodes

In AC bronze welding, you get faster production with this sensational, improved electrode

The old AC bronze welding problems of hard striking and snuff-outs are eliminated through use of the new, improved Ampco-Trode "AC" bronze electrode. As the alternating current flows from positive to negative, the electrode operates continuously without the annoyance of restriking to establish the arc. Faster production results, saving time and money.

This new aluminum bronze electrode can be used with alternating current transformers, having a 75-85 open-circuit voltage, and direct current generators — for welding dissimilar metals, as well as cast iron, malleable iron, bronze, and some nickel alloys. Ampco-Trode "AC" can also be used with reverse polarity for direct current welding. Furthermore, the improved Ampco-Trode "AC" produces unusually smooth beads that feather-edge perfectly into the base metal. Beads are free from porosity and surface pitting. Due to the shielded arc effect, spatter loss is low.

Ask for information about improved Ampco-Trode "AC" electrodes. Call on our distributor.

Only Ampco makes a complete line of Aluminum Bronze Electrodes for both arc and resistance welding.

AMPCO

Ampco-Trode is a product of

Ampco Metal, Inc.

Department WJ-4, Milwaukee 4, Wisconsin

W-97

(*Continued from page 344*)

pleting his course work on the campus, a Fellow conducts his thesis research in the Battelle laboratories under a cooperative arrangement between Battelle and his university.

Fellows receive a stipend of $1200 a year, and they devote at least eleven months to their research. Funds are also set aside for supplies, equipment, supervision, traveling expense of the student and his faculty adviser, and publication costs.

In special cases candidates for the Master's degree may also be appointed, at a lower stipend.

Associateships are open to young men who have completed their academic training and have shown exceptional aptitude for research, either as graduate students or in subsequent employment. Preference will be given to those who hold a Ph.D. degree or who possess an equivalent command of their subject.

The applicant's objective may be to familiarize himself with Battelle's methods of conducting organized research, to learn a particular research technique, to develop a needed research tool, or simply to carry out a research program in one of Battelle's fields of specialization.

The stipend of an Associate is adjusted to his preparation, experience and promise.

In addition to their laboratory experience at Battelle, Fellows and Associates participate in a program of evening lectures, seminars and round-table discussions designed to acquaint them with the philosophy and methods of organized industrial research.

Battelle Memorial Institute is an endowed, nonprofit research organization serving industry through both basic and applied research. The fundamental work done by Fellows and Associates is independent of the research in applied fields conducted by Battelle for industry.

Battelle's Fields of Research: Industrial Physics; Electronics; Theoretical and Applied Mechanics; Physical Chemistry; Organic Chemistry; Electrochemistry; Fuels and Combustion; Ceramic Technology; Mineral Processing; Metallurgy—Physical, Process, Ferrous, Nonferrous High-Temperature Alloys; Welding; Foundry Technology; Metals and Chemicals in Agriculture; Production Research; Science and Technology of the Graphic Arts.

The Institute will consider applications from men interested in any of the fields listed above. Battelle will suggest suitable problems to candidates desiring such guidance, or receive applications from persons proposing problems of their own selection. Inquiries may be addressed to the Institute at 505 King Ave., Columbus 1, Ohio.

AMERICAN WELDING RELOCATES SALES OFFICE

Transfer of the Cleveland district sales offices of The American Welding & Manufacturing Co. from Warren, Ohio, to Cleveland, is announced by M. R. Minnick, sales manager of the company.

"Arc Booster" Simplifies AC Welding

Lincoln Electric announces new industrial type AC welder

A NEW heavy-duty transformer type welder, the "Fleet-Arc" has been introduced by The Lincoln Electric Company which improves AC welding by affording greater ease of arc striking, deeper penetration at the start, wider range of output, greater economy of operation and greater safety. It is applicable to a wide range of applications throughout industry.

A feature known as the "Arc Booster" gives the arc a burst of current the instant the electrode touches the work, starting the arc automatically. The current then returns in a fraction of a second to the amount set for the job. A selector switch provides adjustment of the booster current for any degree of arc striking intensity to suit the job.

Improves Penetration at Start

To improve penetration at the start of a bead, the "Arc Booster" of this new welder can be set to dig in with deep penetration. This is especially important for tack welds and short beads.

Improves Arc Characteristics

The welder has a reactor type of control which is a free circuit, designed for high responsiveness to changing arc conditions. It is separate from the main transformer which is designed for high efficiency. This design gives high arc sensitivity for maximum ease and speed of welding under all conditions; it makes possible an exceptionally wide range of output; and it improves power efficiency.

Current Adjustment is Continuous

The rotating reactor control provides step-less, smooth, accurate adjustment of welding current over the entire range of the welder. The operator simply turns a hand wheel. A double reduction chain drive makes it easy to turn the control and requires a minimum number of turns of the handle to cover the range. The amperage is indicated on a dial on the front of the welder.

The reactor current control is held in position by rugged cone brakes, preventing vibration and wear of the control mechanism.

Increases Safety

The open circuit voltage of the "Fleet-Arc" AC welders never exceeds 63 to 70 volts (depending on welder capacity). This eliminates the hazards of the high open circuit voltages which are used in the usual AC welders to improve arc striking.

Reduces Idle Power Consumption

The independent control circuit eliminates the need for high open circuit voltage, contributes to higher power factor. By reducing amount of condensers needed as much as 66%, this new welder minimizes idle power input.

Is Completely Self-Protected

A thermostatic device protects the windings of the welder from damage due to overheating, opening the welder's magnetic starter under such conditions. This feature permits the welder to be used at high current values for sustained periods without danger of burn-out.

Immediate Delivery

The new welders are available from stock in ratings of 200, 300 and 500 amperes. Complete information on the "Fleet-Arc" AC Welders is given in Bul. 366 which may be had by writing The Lincoln Electric Company, Dept. 124, Cleveland 1, Ohio.

Advertisement

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BURDOX WELDING • CUTTING SAFETY EQUIPMENT

REGULATORS and GAUGES
Outstanding for Accuracy

CUTTING and WELDING TORCHES
for every purpose

LIFT FRONT GOGGLES
Head protector mounts goggles

EXTRA FLEX WELDING CABLE
Helps the Welder do a better job

STREAMLINED LIGHT WEIGHT
HELMETS & HAND SHIELDS

PORTABLE CYLINDER TRUCKS
Nothing like them at any price

PLASTIC FACE SHIELDS
Wide vision wide protection

CYLINDER CONNECTIONS
All brass, precision made

Take advantage of big savings in time and money by standardizing on BURDOX products for all your welding and cutting needs. Designed by welding men for welding men, every BURDOX product offers you the latest improvements and superior quality at prices that mean savings to you. At all leading welding supply distributors.

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Since 1924
IF IT'S FOR WELDING OR CUTTING, WE HAVE IT!

SEND ME A FREE COPY OF THE NEW BURDOX 64-PAGE CATALOG.

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H. R. Ormerod, district sales manager, will continue direction of activities in the district, which comprises northeastern Ohio, western New York and western Pennsylvania, and will make his headquarters in the Union Commerce Building.

The American Welding & Manufacturing Co., established in Warren in 1918, offers engineering service and contract production in the welding and fabrication of parts and assemblies in both ferrous and nonferrous materials.

R.P.I. BROCHURE

The new responsibilities of science and engineering education are defined in a brochure being issued by the nation's oldest school in that field—Rensselaer Polytechnic Institute, of Troy, N. Y.

The school points out that in addition to training students to become "proficient scientists and professional men," there must henceforth be greater emphasis on training students to become "intelligent citizens conscious of their duties in a new era imposing wider responsibilities."

"They must," it adds, "have a broad understanding of the implications of civilized living if they are to be entrusted with the instruments, powerful beyond imagination, which have been fashioned by contemporary science and technology."

Therefore, in addition to academic standards of professional school level, there must be a wide variety of extracurricular activities for further development of personality and enrichment of the spirit, it is stated.

R.P.I. claims a uniqueness in being a professional school having a 150-acre campus and other facilities which makes possible such extracurricular broadening. Founded in 1824, it conferred the first degrees in engineering, and is planning for its 125th anniversary. Current enrollment is about 3600.

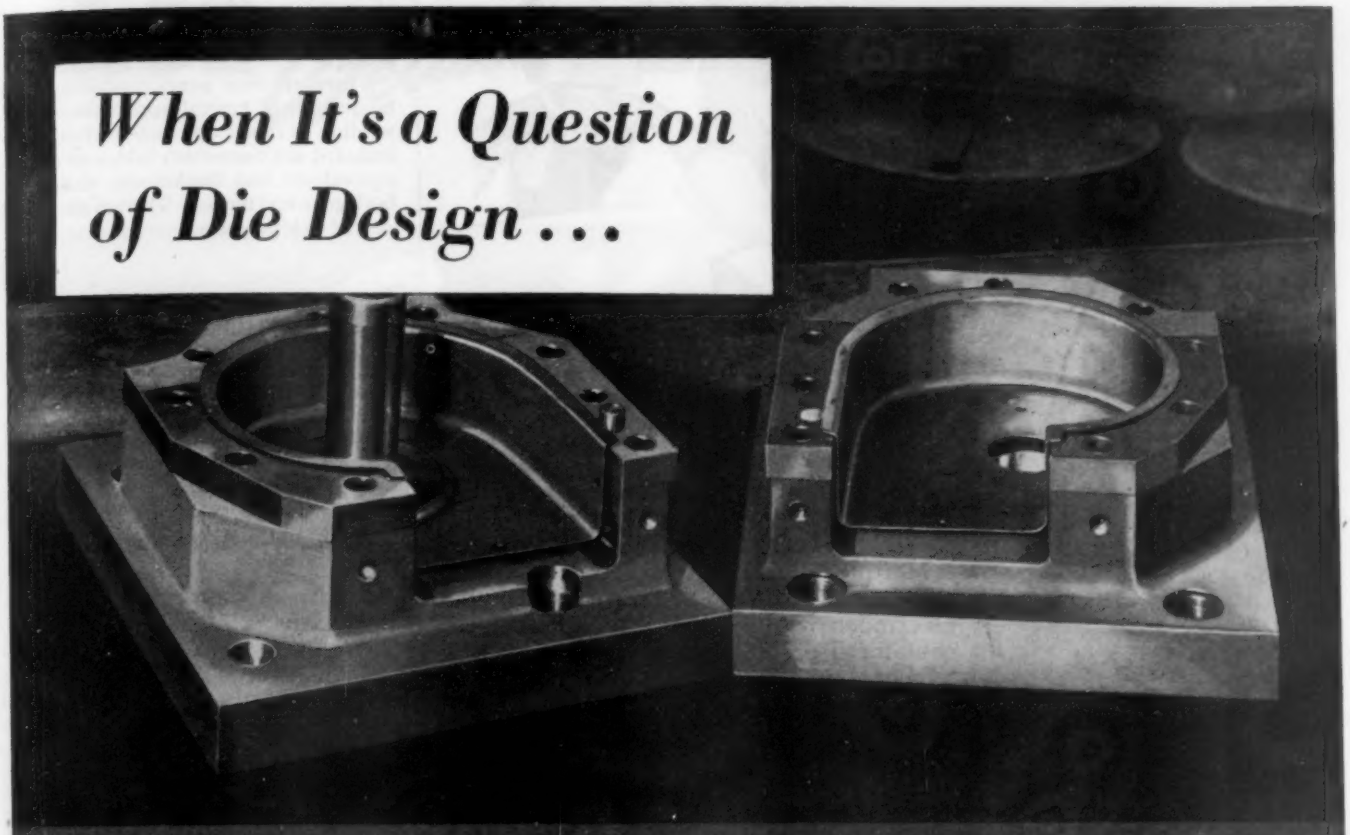
"LEARNING TO WELD"

"Learning to Weld," published by The Lincoln Electric Co., Cleveland, Ohio, 32 pages, $5^1/_2$ x $8^1/_2$ in., 83 illustrations including photos and drawings, bound in good quality paper cover, price postpaid anywhere in U.S.A. 25¢ per copy, elsewhere 35¢ per copy.

"Learning to Weld" provides a simple basic approach for anyone interested in making a start in arc welding. The booklet's purpose is to teach how to weld and to assist in applying arc welding to the repair of broken parts, the hard surfacing of worn parts and the building of miscellaneous equipment. From the information contained in the booklet, the person interested in arc welding gains clear insight into important aspects of the subject on which he may add further knowledge as he desires.

Subjects treated include the following: protective clothing and equipment; striking the arc; various welding positions; types of welds; fit-up of parts; procedures

When It's a Question of Die Design . . .



. . . Bring your problems to RESISTANCE WELDING ELECTRODE HEADQUARTERS

They don't *look* especially difficult to make, these projection welding dies designed by Mallory for manufacturers of the South Wind Heater. But years of experience lie behind them—experience unparalleled in the resistance welding industry.

Mallory "know-how" has been instrumental in establishing widely-accepted standards for electrodes and water-cooled holders . . . in designing better dies, shafts, bushings and other current-carrying parts . . . in developing important copper base alloys and refractory materials. Two of these alloys—Elkonite* and Mallory 100 Metal—are especially useful in the making of dies. They withstand high temperatures and pressures over long periods of operation . . . produce thousands of welds before redressing is necessary.

Fact is, Mallory should be your headquarters on *all* matters relating to resistance welding dies and electrodes. Whether it's a question of design *or any other problem*, our engineers will be glad to help.

In the United Kingdom, made and sold by MALLORY METALLURGICAL PRODUCTS, LTD. (An Associate Company of Johnson, Matthey & Co., Limited), Hatton Garden, London, E. C. 1

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ELECTRODES — HOLDERS — SPECIAL DIES AND FIXTURES — ELKONITE*— ALLOY ROD AND BAR STOCK — FORGINGS — CASTINGS — ACCESSORIES

*REG. U. S. PAT. OFF.

RESISTANCE WELDING MATERIALS

Buy the
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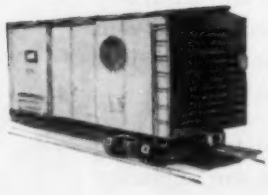
5 And 10 POUNDERS

Marquette Leads Again! . . . to give you a choice of 17 TYPES of famous Marquette Electrodes in ALL SIZES. Each ROD-PAK contains 5 or 10 pounds of one size and type of electrode. Instantly identified, size and type are clearly printed on both ends of ROD-PAK. Handy to use, handy to stock. Makes it easy to keep a fresh supply of Marquette Electrodes in all types and sizes.

Buy the **WELD·ALL KIT**

12 types of rod in one handy package. Contains the right rod for every welding job . . . each rod a leader in its class. Ideal for maintenance jobs where "time is money", the Marquette Weld-All Kit furnishes a practical supply of rods for fast, low cost repairing of anything that comes along. This generous supply of Marquette Electrodes is an actual $21.90 value

LOW BARGAIN PRICE $14.95



Buy the **CARLOAD**

Use Marquette Electrodes on your production line and notice the fast, flawless welds they produce . . . the speeded-up production and the lower costs. Our Marquette Welding Engineers will be glad to recommend the best Marquette Electrodes for your particular job. Order Marquette Electrodes in standard containers, by the box or by the carload. Special discount on single orders over 250 lbs.

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A.C. ARC WELDERS · ELECTRODES
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for various welds including fillets in horizontal, flat, vertical and overhead positions, butt welds, lap welds, corner and edge welds; welding cast iron; hard surfacing.

There are four pages containing 22 illustrations of typical applications of arc welding in repair and construction. Also included are conversion tables on decimal equivalents and thicknesses of metal in both gage and inches. There is also a glossary of welding terms.

WELDING BOOKLET

A new pictorial booklet "Learn Arc Welding" has just been published by the Hobart Trade School, Inc., Troy, Ohio. The functions and courses of study pursued at the school are explained in this 24-page publication which may be obtained free of charge by writing the Registrar of the school.

WELDED FACTORY BUILDING

Something new in this area is being done at present in the erection of structural steel for buildings. Van Construction Co is contractor for a one-story factory building being erected on North Drennan St., Houston, Tex., for Continental Spring Co., and the structural steel design is such that no shop fabrication has been necessary. Some work on members had to be done in the field prior to erection, particularly on knee brackets at columns, but most of the members were erected without connection lugs and bolts.

This building, designed by J. B. Dannenbaum, Consulting Engineer, is 440 ft. long and 120 ft. wide. Columns were made from 8-in. H Sections, and main roof members and knee brackets were cut from 14 inches at 30-lb. WF sections. Metal decking is being used on the roof, and all field connections are being welded.

RICE PROMOTED

Bent Laune, President, All-State Welding Alloys Co., Inc., 96 West Post Rd., White Plains, N. Y., announced the appointment of Dudley B. Rice, associated with S. S. Callner, All-State regional manager in Chicago, Ill., to represent his company in the distribution of low-temperature welding and brazing alloys and fluxes. Mr. Rice is well known in the welding industry. He has been a consultant on welding since 1938 and has written a number of papers on welding procedures for trade journals, including *Welding Engineer*, *Railway Maintenance*, and THE WELDING JOURNAL. He is a member of Fusioneers and of the Chicago chapter of the AMERICAN WELDING SOCIETY.

Before coming to S. S. Callner & Co., Mr. Rice served as welding foreman and specialist in track problems with the Erie Railroad; sales engineer for American Manganese Steel Co.; and as welding engineer for the U. S. Army Ordnance Dept. He was also associated with the Conant Tool & Engineering Co. and with Eutectic Welding Alloys Co.

PAGE *Welding* ELECTRODES

C+X=S

WHERE:

C= COMPLETE RANGE OF ELECTRODES AND GAS WELDING RODS

X= EXPERIENCED FIELD SERVICE MEN TO RECOMMEND CORRECT RODS AND TECHNIQUES

S= SAVINGS IN WELDING COSTS

This is the PAGE formula for economy in production welding. The uniformly high quality of PAGE welding electrodes and rods is not included, because that is simply taken for granted by experienced welders.

Through PAGE Field Service Men, your PAGE distributor can give you valuable up-to-date information on welding techniques and selection of electrodes. That's why we say . . .

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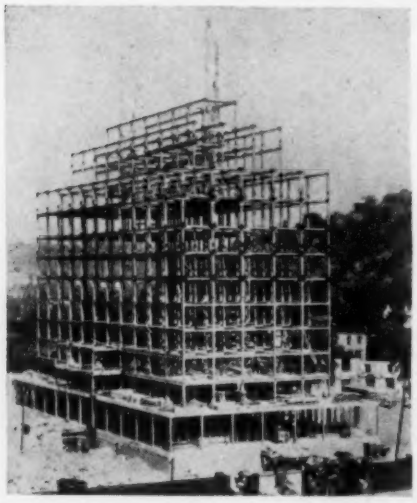
TRADE MARK

KENTUCKY STATE OFFICE BUILDING HAS ALL-WELDED STEEL FRAME

The structure seen here (Fig. 1), is an outstanding example of all-welded steel frame construction. It was built several years ago, and houses many of the executive offices of the Kentucky State Government.



The building is located in Frankfort, the capitol city, and is located directly across the Kentucky River from the capitol building.

This building is a 14-story structure, having one-bay setbacks continuously

around the building at the second, eleventh and penthouse floor levels and having a main shaft which is 214 ft. wide by 84 ft. deep. Connected to the rear is an auditorium with a seating capacity of 1500 people.

The general construction (see Fig. 2), comprises: reinforced concrete footings supported on precast concrete piles; an all-welded steel frame; reinforced solid concrete two-way floor slabs; exterior walls of cut stone to the first setback at the second floor level, and gray brick from that level upward. It is fireproof throughout.

The all-welded steel frame stands out as a decided step foreward in modern design, and is one of the largest buildings of welded frame in the United States, having a total tonnage of 1470 tons. Welding reduced the steel tonnage 10% and effected an estimated saving of at least $20,000.

BUDD DESIGNS RAILROAD SLEEPING ROOM WITHOUT CURTAIN AT DOOR

A new design of single occupancy room-type sleeping car accommodations was announced by officials of The Budd Co.

The new type "Cabin" is constructed so that the passenger can lower his berth into position without stepping into the corridor or requiring the assistance of a porter. There are no door curtains.

"Since the earliest development of railroad sleeping accommodations, one of the most vexing problems has been the fact that the passenger has always been inconvienced when it became necessary to convert his berth for night use," said Edward G. Budd, Jr., president of The Budd Co. "We have eliminated this inconvenience. By applying space engineering we have created comfort and privacy for the passengers and additional revenue for the railroads. In our new Cabins the passenger can operate his own berth while standing entirely within his own Cabin with the door closed. The room is his own."

During the day the Cabin is equipped with a sofa-type seat and the berth is concealed in the wall behind the seat. When the passenger is ready to retire he turns a simple handle which releases two safety catches, and the perfectly counterbalanced berth is easily lowered into a horizontal position.

A radical new development in lighting

National

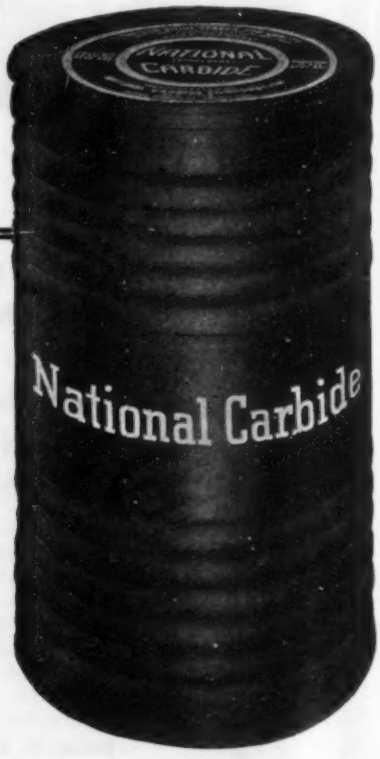
Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

DEPENDABLE



FOR WELDING and CUTTING

Use National Carbide in the Red Drum

Write us for information as to nearest available stock.

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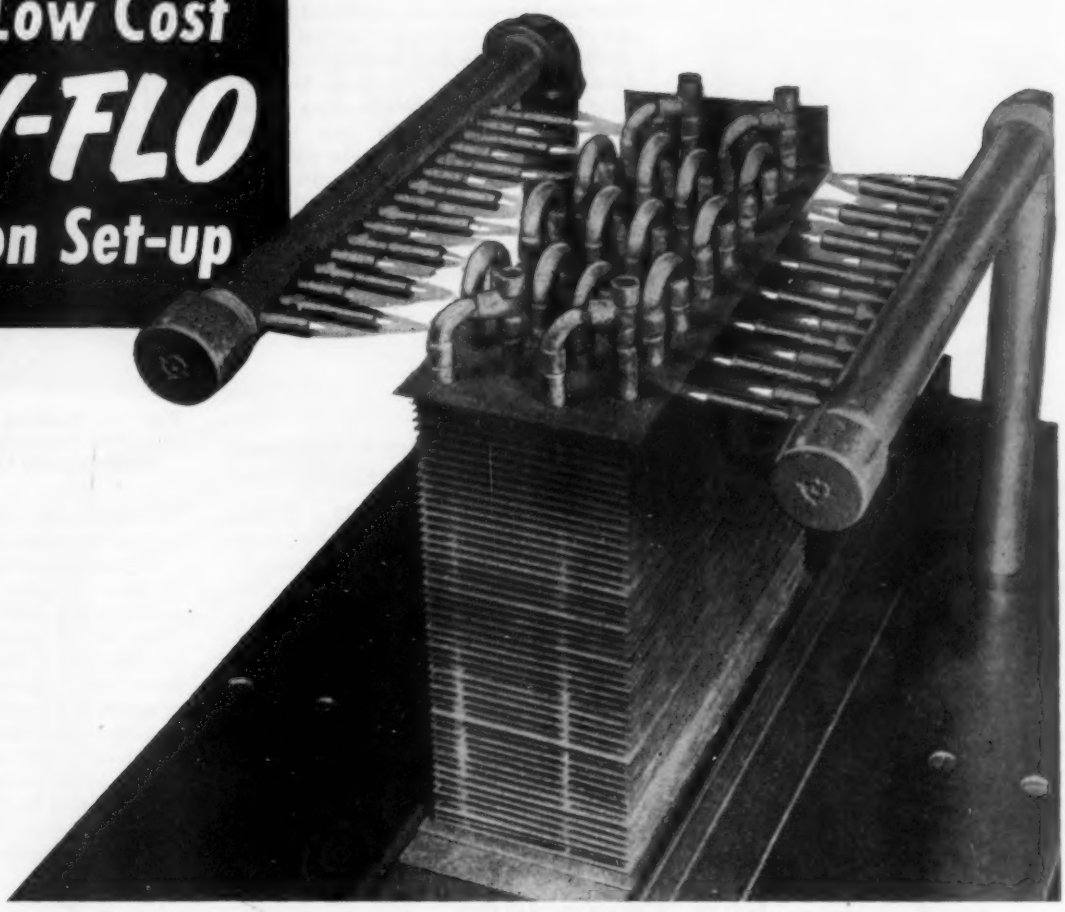
A Fast..Low Cost EASY-FLO Production Set-up



32 LEAK-TIGHT JOINTS BRAZED IN 45 SECONDS!

With the simple set-up above, the 16 return bends of —— copper are joined to the tubes of the refrigeration unit — all at one time — all automatically — all in 45 seconds.

HERE'S HOW IT IS DONE

Units are prepared for brazing as follows. Return bends are cleaned and fluxed and a ring of 3/64– "EASY-FLO wire is inserted in each open end — bends are placed over the cleaned and fluxed tube ends of the unit — Assembly is then placed between the two rows of gas-air burners, with a flame aimed at each joint. The predetermined brazing time of 45 seconds is governed by an automatic timer and solenoid valve which shut off the main gas supply, leaving a pilot burning. With assemblies being prepared while others are brazing, production moves along in a steady stream.

YOU CAN DO IT TOO

You can get equally fast, economical results with similar procedures designed to get full benefit of the fast action and exceptional fluidity of the low-temperature silver brazing alloy EASY-FLO. We have helped many manufacturers work out such procedures. We are ready to help you. WRITE FOR BULLETIN 12-A which tells all about EASY-FLO. Ask especially for details about the new EASY-FLO 45.

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Budd's Cabin Can Be Made Ready for Night Occupancy Without Stepping Into the Passageway of the Car

The ingenious use of space adds this privacy feature to the greater comfort and convenience of this luxurious accommodation. Designed for single occupancy, these Cabins are complete in every detail—individually controlled fluorescent lighting and air conditioning, toilet facilities, wash basin, luggage storage space and large full-length mirrors.

has been installed on both sides of the large mirror above the wash basin.

There will be 22 of these private units in each of the Cabin cars Budd is building for several of the major railroads. In other cars the space will be divided to furnish six Double Bedrooms and ten of the Cabins. The Double Bedrooms are so arranged that two of them can be combined to form a Master Drawing Room with accommodations for four people. Thus, in one railway car, Budd engineers have made it possible for the railroads to supply every desirable type of sleeping accommodation from the single Cabin to the four-passenger Master Drawing Room. The Budd Co. uses welding extensively in the construction of these cars.

SHEET METAL ASSEMBLY IMPROVED BY RESISTANCE WELDING

Resistance welding has enabled Walker and Co. of Detroit—probably the largest producer of sheet metal display signs—to reduce construction time and improve the appearance of their completed signs.

The components of Walker and Co. signs—frame, side, box, cover, mounting brackets, clips, etc.—were formerly assembled by bolting and/or riveting. Materials used for these signs include stainless steels, galvanized coated steels, mild steels, etc., according to individual product requirements. There is also considerable variation in the weights of the different kinds of sheet, including gages from 24 to 16. Structural steel reinforcements and support members are up to $^1/_8$ in. thick.

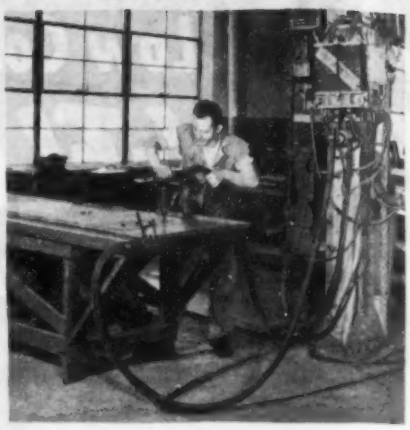


Fig. 1—Welding Reinforcements and Mounting Brackets in Box for a Sign with Hydraulically Operated C-Type Gun

The change-over to resistance welding in place of more conventional assembly methods has cut considerable time and labor off the production of the average Walker sign. Standards of appearance have been maintained and the welded products are reported to be even stronger than were the bolted and riveted ones.

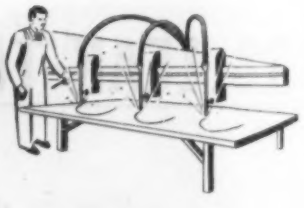
The resistance welding equipment used (shown in the accompanying photographs) was produced by Progressive Welder Co., Detroit, to meet Walker's specific product design and manufacturing problems. Fig-

FOR THESE JOBS . . .

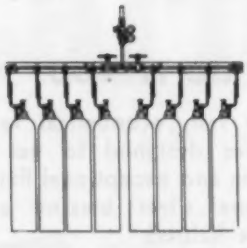
Production Welding

. . . and operations such as welding and cutting heavy sections with hand torches, flame hardening and softening, flame cleaning . . . also any installation where a battery of cylinders is required.

Production Cutting

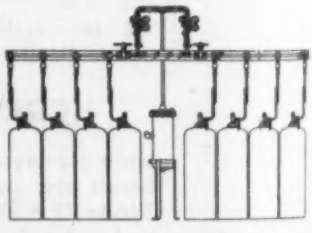


YOU NEED THESE MANIFOLDS . . .



REGO Oxygen Manifold

REGO Acetylene Manifold



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● ***Added Convenience***...Individual shut-off valves at each cylinder station permit the removal of any cylinder without shutting down one side of the manifold. Master shut-off valves control flow of each bank of cylinders.

● ***Unit Construction***...Header assembly, mounted to steel I-beam, is virtually one piece. Extra-heavy pipe is run through header fittings, cylinder station shut-off valves and master shut-off valves with all permanent connections silver-brazed.

● ***Precision Regulation***...Uniform delivery pressure is assured by large capacity two-stage Regolators.

● ***Exacting Tests*** . . . Every RegO Manifold is subjected to a sustained air pressure test before shipment.

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FOR ATOMIC-HYDROGEN WELDING

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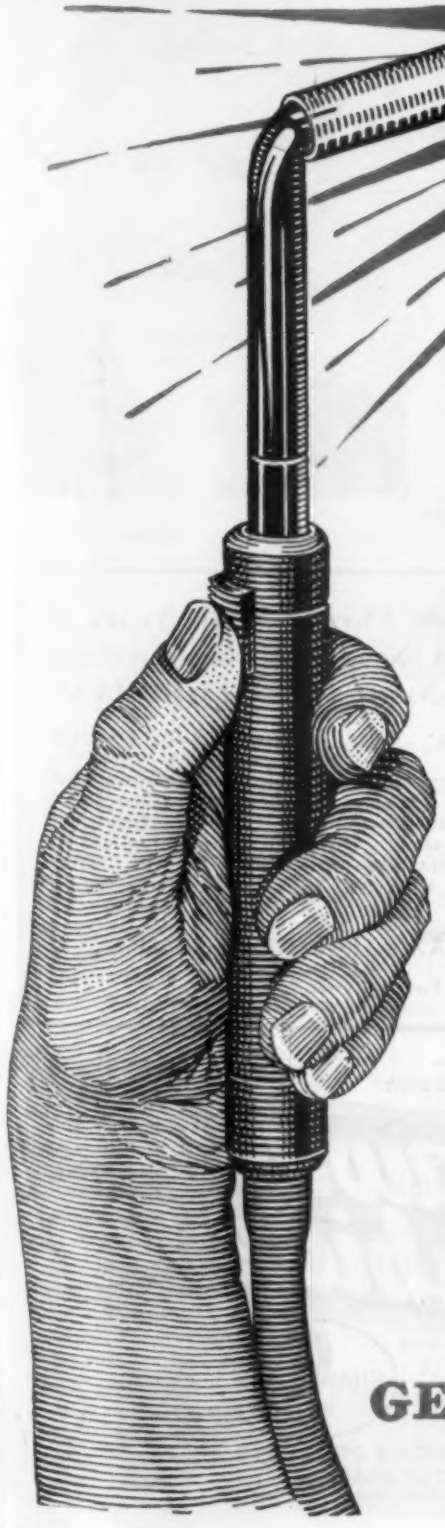

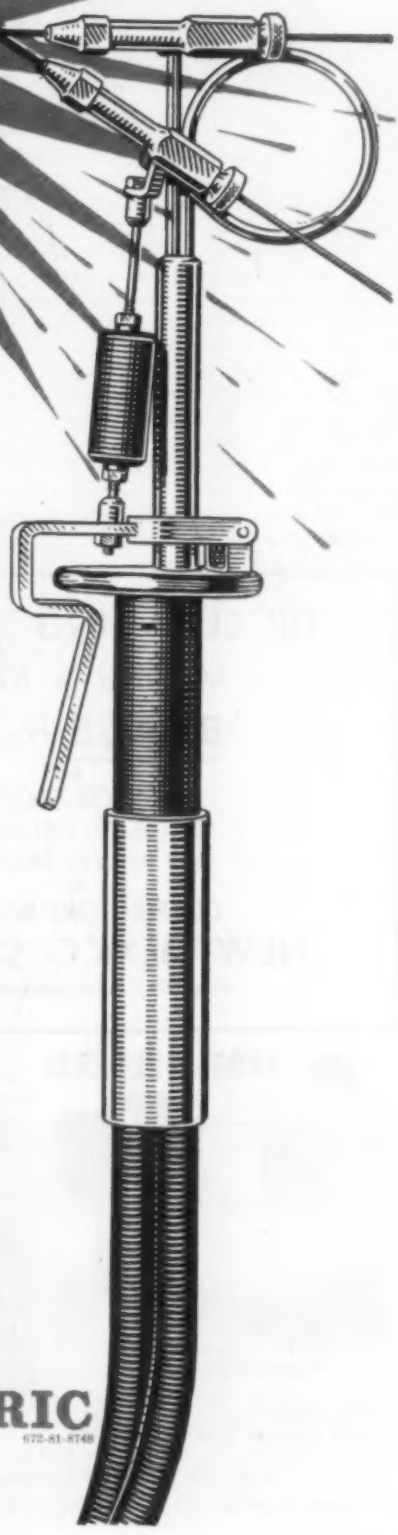

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General Electric specifications state:

Tungsten electrodes shall be—

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For use with the Inert-Arc process, electrodes of ground finish are recommended. Diameters shall be held to 0.001 inch tolerance.

***Your local General Electric Distributor can supply these tungsten electrodes from stock, or write** Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

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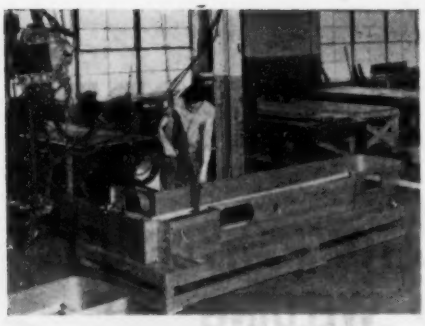

Fig. 2—Using the Push Gun Part of the Equipment Shown in Fig. 1 to Weld Clips on Wide Sheets

Fig. 3—Compact, Streamlined Progressive Standard Rocker Arm Welder Used at Walker and Co. to Weld Clips to Stainless Steel Letters. These Letters Later Will Form a Large Sign

ure 1 shows the welding of reinforcements and mounting brackets in a sign box. This C-gun has a 12 in. throat depth—ample to take care of the deeper sign boxes, which run up to 10 in. in depth, yet sufficiently small to permit easy handling.

Figure 2 shows the manner in which the push gun, which is part of the same equipment shown in Fig. 1, is employed for spot welding clips to covers. It is also used for welding operations on sheets too wide for convenient handling in the rocker arm welder shown in Fig. 3.

Figure 3 illustrates the compact, Progressive standard rocker arm welder being used to spot weld clips to stainless steel letters, which later will form a large sign. Extra long adapters and special long electrodes make it possible to use the machines for work requiring a considerable amount of throat depth to clear flanges, etc.

USE OF OXYGEN IN THE OPEN HEARTH

This article explains one of the most sensational developments in the steel industry in 1946. It covers the possibility of increasing production by firing oxygen with the regular fuel during the meltdown. Currently, experimental applications of this new process are being made to test its economic value. Written by Dr. G. V. Slottman, Manager of Air Reduction's Technical Sales Division and F. G. Kerry, Manager of the Development & Engineering Department of the Canadian Liquid Air Co., this article is offered in 8-page booklet form illustrated with both photographs and diagrams.

Copies may be obtained by writing Air Reduction, 60 E. 42nd St., New York 17, N. Y.

DE HAVEN HEADS OHIO STATE WELDING ENGINEERING COURSE

Clarence C. DeHaven has been appointed Assistant Professor and will head the Welding Engineering School of Ohio State University. Professor DeHaven was born in Berlin, Pa., Dec. 8, 1904; graduated from Berlin High School in 1920; from Williamson Trade School in 1925; and received B.S. in Mechanical Engineering at Drexel Institute of Technology in 1932.

Clarence C. DeHaven

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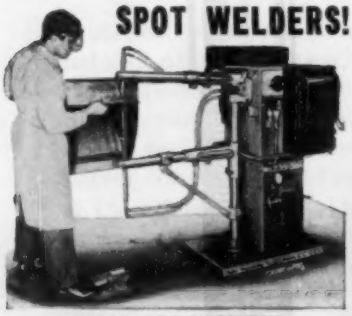

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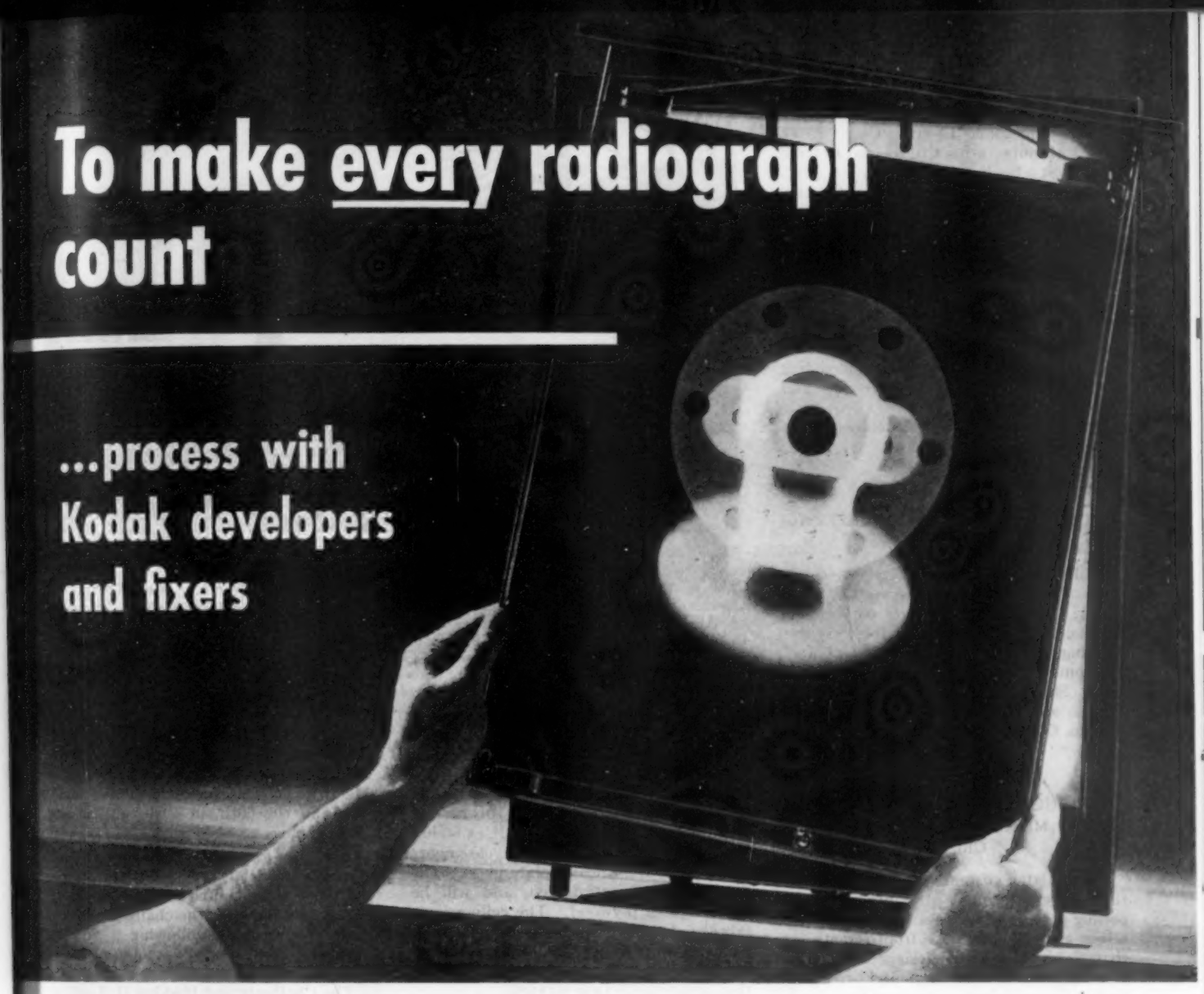

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Professor DeHaven was connected with: The Philadelphia Electric Co.; E. G. Budd Manufacturing Co. (helped to build the first Burlington Zephyr—a 95% welded stainless steel train); Western Electric Co.; and Socony Vacuum Oil Co., *et al.*

He was instructor in Mechanical Engineering at Drexel Institute of Technology for 6½ yr., teaching welding, heat treating, materials testing, machine shop and physics. In E.S.M.W.T. he outlined, supervised and taught a sequence of six courses in Welding Engineering, including Processes, Welding Metallurgy and Welded Design.

Professor DeHaven is a member of the AMERICAN WELDING SOCIETY.

FORMAN JOINS UNITED ENGINEERING CO.

Milton Forman has recently joined the staff of the United Engineering Co., Alameda, Calif., in the capacity of Welding Engineer. Mr. Forman was formerly the welding engineer for Emsco Derrick and Equipment Co., Los Angeles, Calif., Ingalls Shipbuilding Corp., Pascagoula, Miss., and Toledo Shipbuilding Co., Toledo, Ohio.

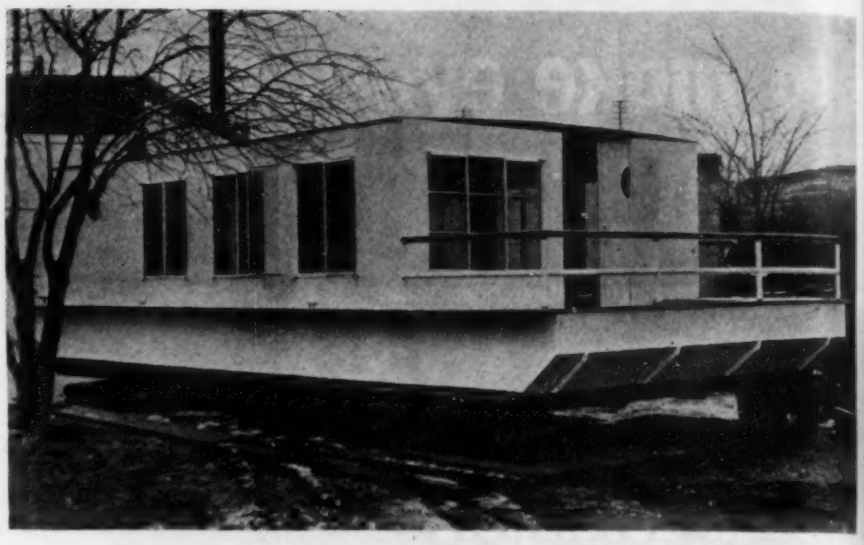
METAL HOUSEBOAT OF ALL-WELDED DESIGN MEETS VETERAN'S HOUSING CRISIS

During the current housing shortage there have been many attempts by enterprising persons to secure a home for themselves and their families from structures that were not initially designed with this end in mind—old railroad and streetcar bodies, Quonset huts, converted barns and garages, and remodeled buildings that served other purposes prior to the present.

But the resourcefulness of a war veteran in Cleveland seems to beat all previous attempts, for he combined his operations and purchased a three-room houseboat that will tide him over during the shortage of homes and suffice as a pleasure craft when conditions become less acute.

The houseboat purchased by this veteran of World War II is an all-metal boat that combines the economy, rigidity and ease of design afforded through its arc-welded construction.

The length overall of this home-on-the-waves is 28 ft., with a continuous beam running 13 ft. 4 in. It has a very shallow draft and draws a minimum of 6 in. of water.



Photo, Courtesy Lincoln Electric Co.

This Is the All-Welded Metal Houseboat That an Enterprising War Veteran in Cleveland Is Going to Use to Tide Him Over the Housing Shortage. The Boat, of All-Welded Design, Contains Three Rooms and Costs Approximately $5000. It Will Soon Be Trucked to the Mouth of the Chagrin River, on Lake Erie, and Will House the G.I. and His Wife

Gross weight of the craft is three tons, which is very little when the size, structure and equipment are taken into consideration.

Basic materials used in the fabrication of this boat were sheet steel in 10-, 12- and 14-gage thicknesses, bar stock 2½ x ¼ in., and metal door and window casements that will contain heavy plate glass. The floor is heavily reinforced, and will be covered with plywood. The ceiling is so fabricated that it can be easily insulated, and the bottom of the hull has been treated with zinc chromate and asphalt that assures a lifetime service.

The interior has been laid out in three rooms—a galley, 5 x 8 ft., a living room 12 x 16 ft., and a shower-style bathroom is accommodated in another little room that also serves for closeting and cabinets.

J. E. Baker of 1325 E. 152nd St., Cleveland, Ohio, builder of the boat, said that more than 400 hr. of arc welding were spent in the fabrication of the home-on-the-waves.

ATLANTIC CITY CHOICE OF A.S.M.E. FOR 68TH ANNUAL MEETING DEC. 1-5

The 1947 Annual Meeting of The American Society of Mechanical Engineers will be held in Atlantic City, N. J., December 1–5, it was announced recently at national headquarters, 29 West 39th Street. This will be only the third time in the Society's 68-year history that it has held the largest of its national gatherings outside of New York City. The 11th Annual Meeting, in 1890, was held in Richmond, Va., and the 60th, in 1939, was held in Philadelphia.

A desire to avoid the hotel congestion in New York which is expected to result from meetings of the United Nations was given as a chief reason for the change. The decision was reached following a vote of members. The Society's total membership is more than 22,000.

The Chalfonte and Haddon Hall will be the Atlantic City headquarters hotels. They have guaranteed 2700 rooms for the meeting. Usually the attendance totals about 6000 but it is expected to exceed that figure greatly this year. Some 200 engineers, scientists and industrialists take part in the program consisting of five days of continuous technical day and evening sessions.

In 1948 the A.S.M.E. expects to return to New York to hold the Annual Meeting at the Hotel Pennsylvania.

Aid to Production

The adoption of a theme for the year's series of meetings also was announced by the Society as follows: "The Engineers' Responsibility in Increasing National Productivity."

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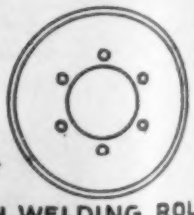

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COMPARE FOR SPEED
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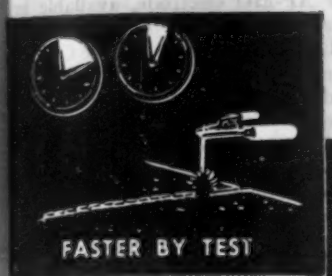

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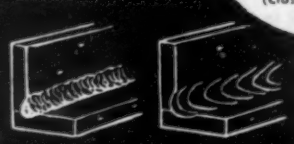
Tests prove DH-2 20% faster! Get more metal deposition per hour, cut welding time and costs, with this improved P&H Electrode.



BETTER APPEARANCE

Improved weld appearance because weld metal literally "feathers out" neat and uniform. No notched effect along weld edges.

MEDIUM OR DEEP PENETRATION

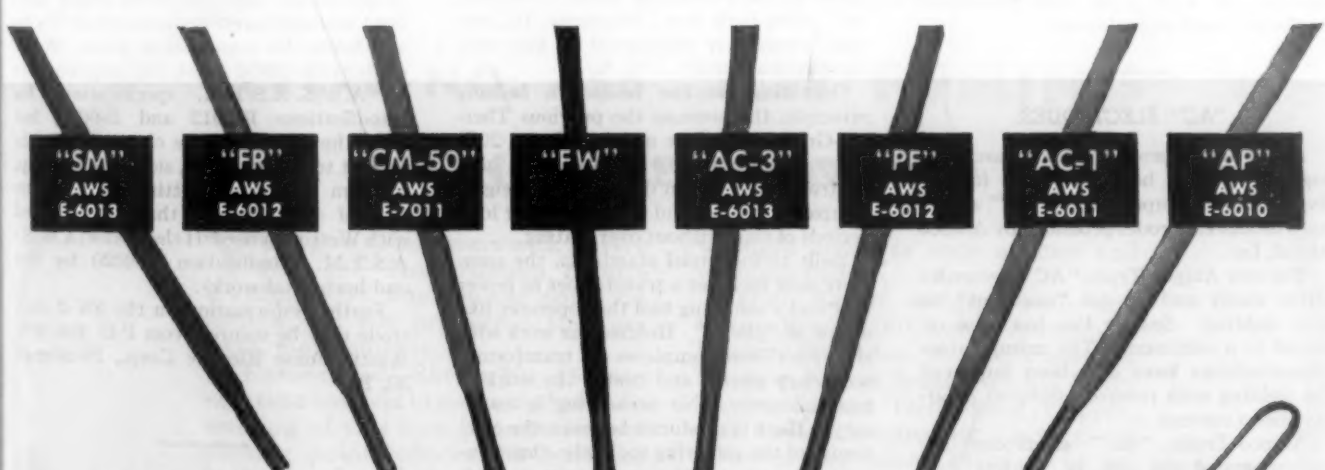
DH-2 provides depth control. Welds at normal amperages for medium penetration — high amperages for deep penetration.

DOWNHAND "SPECIALIST"

Improved DH-2 performs extremely well for all horizontal, flat fillet and groove welding. It meets and beats today's requirements for all positioned welding.

OTHER P&H ELECTRODES MEET *ALL* REQUIREMENTS

Whatever your electrode needs, P&H can supply the correct sizes and types. Here are a few of P&H mild steel electrodes. Others for alloy and stainless applications —for cast iron and for building up and hard surfacing.



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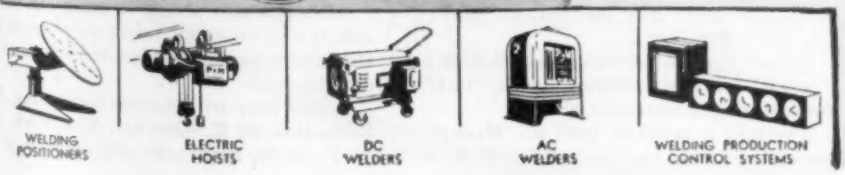

P&H ARC WELDERS

Made by one of the world's largest builders and users of arc welding equipment, P&H welders offer many added values in construction and operation. Model WA-200 shown has welding service range from 30 to 285 amperes, other AC and DC models to 1250 amperes.

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

STAINLESS STEEL ELECTRODES

A complete line of stainless steel electrodes in a full range of grades and diameters has been announced by Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y.

All Airco stainless steel electrodes are furnished with a heavy extruded lime type coating for d.-c. application. In addition all but the straight chrome analyses are obtainable with a lime-titania type coating which is usable on a. c. or d. c. The slag produced by either of these coatings is easily removed.

Electrodes with the lime-titania (a.c.-d.c.) type coating offer many desirable features not found in the lime type coated electrodes. For example, satisfactory usability on a. c. eliminates arc blow and results in easier manipulation, more uniform arc action and better appearance of deposit. This class of electrodes can be recommended for all applications on which the lime type of electrode is used, with the possible exception of highly restrained joints on heavy sections or on steels of high hardenability.

Further information on the new Airco line of stainless steel electrodes can be obtained by writing the New York office or the nearest Airco sales office.

"AC" ELECTRODES

A new and improved, shielded-arc coating has recently been developed for the five grades of Ampco-Trode "AC" aluminum bronze electrodes produced by Ampco Metal, Inc.

The new Ampco-Trode "AC" electrodes strike easily and do not "snuff-out" on a.-c. welding. Spatter loss has been reduced to a minimum. The manipulative characteristics have also been improved for welding with reverse (positive) polarity, direct current.

Ampco-Trode "AC" electrodes are recommended for use in welding cast irons, malleable irons, aluminum bronzes, silicon bronzes, some nickel alloys and dissimilar metals with a.-c. transformers having a 75–85 open-circuit voltage and d.-c. generators.

Additional information may be obtained from Ampco Metal, Inc., Milwaukee 4, Wis., upon request.

ARC WELDING COMPOUND

POM is a new, improved arc welding compound developed to produce cleaner, better welds. It is an electrically conductive composition of inorganic minerals which supplement the fluxing action of the welding rod coating. It stabilizes and quiets the welding arc, prevents arc breakage, improves fusion and prevents scale on both sides of the weld bead. POM also prevents adhesion of weld spatter to parts being welded . . . thereby eliminating spatter-cleaning operations.

POM contains no oils or other combustible ingredients and therefore causes NO smoke, fumes or odors under the heat of the welding arc. POM is a paste which is thinned by the user with an equal part of water and is brushed or sprayed into the seam to be welded and on adjacent surfaces where spatter usually collects. After welding, all spatter and compound are quickly wiped off with a dry cloth leaving a spotless weldment ready for painting POM contains a rust inhibitor so that it can be applied to the steel at any time before welding and will protect the parts from rust until they are fabricated. POM is packaged in 1- and 5-gal. pails. Manufactured by G. W. Smith & Sons, Inc., 5400 Kemp Rd., Dayton 3, Ohio.

NEW ELECTRIC SOLDERING TOOL

The popular Thermo-Grip Soldering Tool, manufactured by Ideal Industries, Inc., 1938 Park Ave., Sycamore, Ill., has been completely redesigned in line with the modern trend.

Operating on the resistance heating principle, the same as the previous Thermo-Grip models, the new unit heats 20% faster, has thumb switch for close heat control, is modern in design, light-weight, compact, portable and can be used for long periods of time without overheating.

Built to industrial standards, the complete unit includes a transformer or power unit and a soldering tool that operates like a pair of "pliers." Holding the work with the "plier" tool completes the transformer secondary circuit and causes the work to heat instantly. No preheating is necessary. Heat is produced between the electrodes of the soldering tool only, thus concentrating it on the exact spot needed. There is no danger of melting nearby joints or burning other parts.

Handles of the "plier" soldering tool are made of light-weight plastic. Radiating fins isolate the meehanite jaws from the handles to prevent excessive heat conduction. The "plier" can be locked in any position for special applications by tightening screw at hinge. The "plier" is intended where work may be held in the jaws and heated—for example, in removing or applying solder lugs, sweating and unsweating copper pipe and fittings, soldering wire joints, etc.

Other types of soldering tools include a "pencil" for spot soldering and a "fork" for soldering in restricted places.

The unit is rated at 1000 w. Modern, streamlined case measures $10^3/_4 \times 8 \times 10^3/_8$ in. overall. All parts tuck away in the case when not in use.

AP-MO ELECTRODES

For d.-c. reverse polarity welding only of low-alloy cast steel or low-alloy high-tensile strength rolled steels in all positions, the new AP-MO electrode, available in three diameters from $^1/_8$ to $^3/_{16}$ in., is announced by Westinghouse Electric Corp.

This electrode is designed for making butt and fillet welds in all positions and welds made with it meet the requirements of A.W.S.-A.S.T.M. tentative specifications for Iron and Steel Arc Welding Electrodes Classification E-7010.

Further information on the AP-MO electrode may be secured from P.O. Box 868, Westinghouse Electric Corp., Pittsburgh 30, Pa.

SW-2 ELECTRODES

For rapid and economical welding of mild steel in all positions and with alternating current or either polarity direct current, straight preferred, the new SW-2 electrode, available in four diameters from $^3/_{16}$ to $^5/_{16}$ in., is announced by the Westinghouse Electric Corp.

SW-2 electrodes were developed in the larger diameters to provide electrodes having the desirable characteristics of the Westinghouse SW electrodes which have been manufactured in diameters of $^3/_{16}$ in. and below, for a number of years. Welds made with SW-2 meet the requirements of A.W.S.-A.S.T.M. specifications for classifications E-6012 and E-6013, but have the very desirable characteristics in respect to flat contours, side wall wash-up, freedom from undercutting and extreme ease of slag removal, that are obtained with Westinghouse DH electrodes (A.W.S.-A.S.T.M. classification E-6020 for flat and horizontal work).

Further information on the SW-2 electrode may be secured from P.O. Box 868, Westinghouse Electric Corp., Pittsburgh 30, Pa.

REMOVAL OF DISSOLVED GASES FROM MOLTEN METALS BY FLUSHING

This 12-page booklet, illustrated by both photographs and diagrams, covers in detail the most efficient and economical method of removing harmful gases from molten metals. This consists of bubbling a dry inert gas through the metal just before casting. Dissolved gas passes from solution by diffusion into rising bubbles and is carried out of the metal mechanically.

Although this article is complete in itself, it also mentions reference sources for the information of anyone desiring further details.

Copies may be obtained by writing Air Reduction, 60 E. 42nd St., New York 17, N. Y., or the Airco sales office nearest you.

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YOU gain in two ways with Revere No. 456 Low Fuming Bronze Welding Rod. For you cut down on fuming and you produce a stronger weld, more quickly.

"Flame-tested" Revere No. 456 can save time and fuel in the straight fusion welding of cast iron because its low melting point reduces the need for high pre-heats and the post-heating so often required. Revere No. 456 also produces strong, sound joints in the bronze welding of cast and malleable irons, wrought iron, cast and wrought steel, as well as cast and wrought bronze.

Other Revere welding rods are: Revere Bronze 380, Revere Manganese Bronze, Herculoy, Revere Phosphor Bronzes, Revere Brass (Brazing Rod), Revere Silicon Deoxidized Copper, and Revere Electrolytic Copper. All come in 100-pound cases or in 25-pound cartons, net weight, and are stocked by Revere Welding Rod Distributors in all parts of the country. Write for folder giving technical data and net prices.

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COPPER AND BRASS INCORPORATED

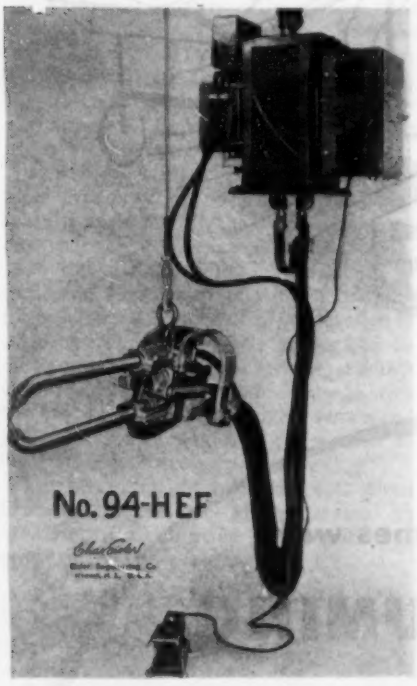
Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N.Y.—Sales Offices in Principal Cities, Distributors Everywhere.

PORTABLE AIR-OPERATED GUN WELDER

A new rocker-type model of a portable gun welder greatly extending its range of application has just been placed on the market by the Eisler Engineering Co., Inc., Newark 3, N. J. The unit shown in the accompanying photograph is an air-operated welding machine with a double acting air cylinder and the necessary operating mechanism. The air cylinder is placed inside the construction, between the lever arms and transmits the pressure to the electrodes by lever action.



This cylinder arrangement is one of the novel features of this latest Eisler gun welder model, providing the advantage to leave a free working space all around the horns, thus increasing and easing the welding possibilities especially at hard-to-get-areas.

The power pact consists of an air-cooled transformer with an 8-tap switch (7 "on" and 1 "off"), a pneumatically or electronically actuated timer and a high-speed mechanical or electronic contactor for accurately timing the weld in speed or automatic repeat of strokes. The welding cycle is initiated by foot switch or push button. The air system includes solenoid operated air valve, air filter, pressure regulator, gage and switch and air line oiler.

Flexible copper straps carry the current from the cable to the electrodes. The horns are made from hard drawn copper and can easily be exchanged to fit throat depths ranging from 8 to 24 in. The water-cooled welding tips are of special high-conductive and wear-resisting alloy, easy to insert and interchangeable. The kva. rating of the welder is from 30 up to 75 kva.

The machine is suitable for spot welding of sheet metal of light gage, but will also weld heavier work when supplied with short holders.

HIGH PRODUCTION WELDER

That a machine designed for maximum output need not be a single-purpose machine is well illustrated by an ultra-speed spot welding machine recently designed and built by Progressive Welder Co., Detroit, for the welding of dust shields to fenders for a popular line of automobiles.

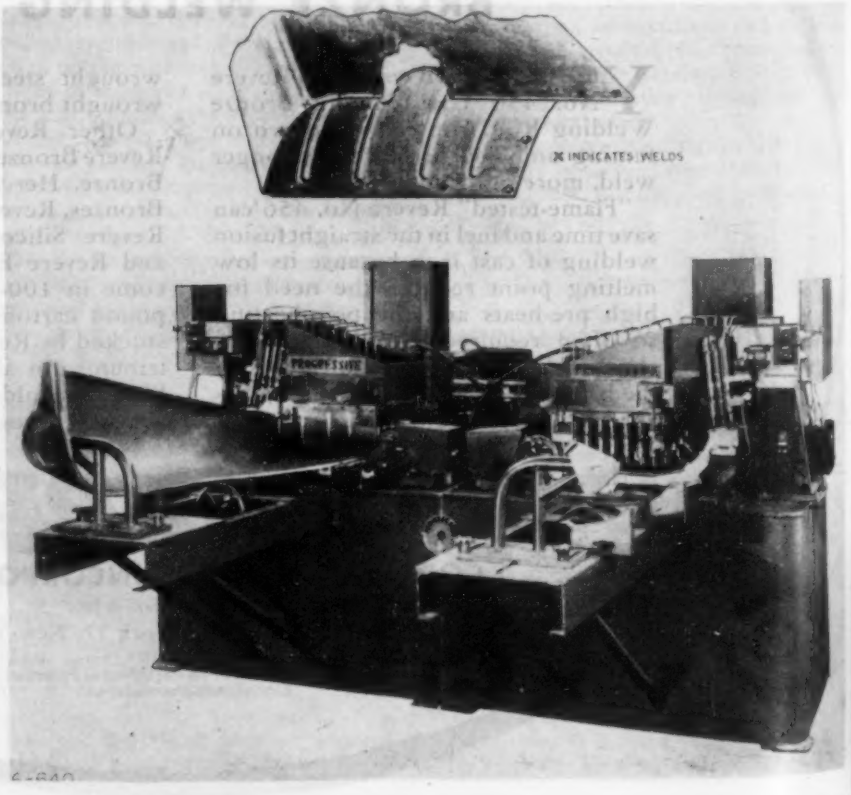
Not only will the machine produce both right- and left-hand front fenders, but by a simple adjustment, made in a few seconds, it will handle two different sizes of fenders interchangeably, at a production rate of 150 assemblies per hour, with 18 spot welds per fender.

In addition, the machine can be operated at "normal" production by a single operator, welding right and left fenders alternately, or two operators may be used, one for right and one for left fenders, thereby virtually doubling production.

The machine is so designed that it can be split into two machines if desired at any time for convenience of material routing in the plant. The only additional equipment which would be required in such an event would be a second hydraulic power unit.

Each half of the Dual Progressive Ultra Speed is equipped with its own ultra-speed unit; its own transformer, timer and contactor. Note that the headlight gage, used to locate the fender, is made adjustable to suit different fender sizes. A hand-wheel operated lead screw movement for the lower electrode facilitates electrode and gun maintenance. Guns are of various types—straight, bell-crank and self equalizing—to permit locating of the various spot welds exactly where desired.

The production achieved with this machine, despite its flexibility is some 140% higher than that obtained with the previous assembly method, without requiring any more physical effort on the part of the operator.



"ARC POSITIONER" FOR AUTOMATIC WELDING

A new service which provides for a greater mobility and a decreasing time-loss factor for users of the latest automatic process of shielded metallic arc welding was recently announced by Mark F. Gouran, Welding Engineer, located at 7426 Devon St., Mt. Airy, in Philadelphia, Pa.

The very name of this fixture—the "Arc Positioner"—befits its versatility of operation, for it is comprised of an automatic shielded arc-welding head, traveling on a beam that encompasses a vertical zone of

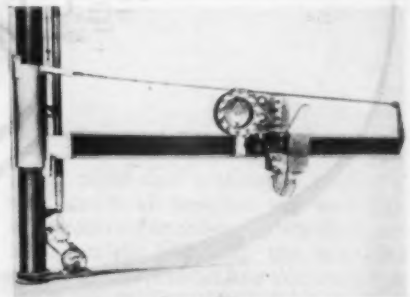


Fig. 1—This Is an Illustration of the "Arc Positioner," Manufactured by Mark F. Gouran, Welding Engineer, in Philadelphia, Pa.

The total assembly, including the beam, head and vertical gear shaft, and motor, rotate around the axis when the operator changes from one job to another.

These aluminum pressure-tight drums are welded four at a time on an automatic carbon-arc welding machine. The aluminum is $\frac{3}{16}$" Alcoa 3S, and Alcoa No. 24 welding flux is used.

All types of welds can be made commercially on aluminum. Standard welding equipment and techniques are used with minor adjustments of flames or machine settings.

The 120-page booklet, "Welding and Brazing Alcoa Aluminum" will be sent to you on request. And our staff of welding specialists will be glad to help you with any welding problems that the booklet doesn't clear up. ALUMINUM COMPANY OF AMERICA, 1933 Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in leading cities.

MORE people want MORE aluminum for MORE uses than ever

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8 ft., with the assembly rotating around a fixed axis to a maximum radius of 20 ft.

This "Arc Positioner" is manufactured in three standard sizes, providing a 10-, 15- and 20-ft. horizontal arc travel.

The traveling assembly is the "Lincolnweld" head and carriage manufactured by The Lincoln Electric Co., Cleveland, Ohio.

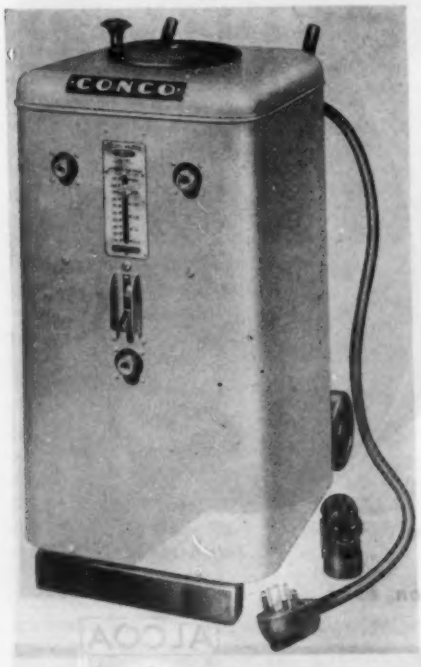
The vertical operation of the head, which is powered by a motor-driven adjustment on the beam, covers an operating zone from the floor upward to a height of 8 ft.

The vertical adjustment of the beam is accomplished at a rate of 36 in. per minute and permits inching the beam up or down to obtain the exact height for any particular welding operation. The beam, in its horizontal applications, may be swung manually 360° about its axis, varying in radii according to the length of the beam. "Arc Positioners" of larger capacities are designed and constructed on custom-built jobs only.

A.-C. ARC WELDER

A new and outstanding portable a.-c. arc welder is now being manufactured in quantities by the Conco Engineering Works, Mendota, Ill., which has been accepted with enthusiasm by garages, service stations, industrial plants and repair shops.

The Conco A.-C. Portable Arc Welder meets REA, NEMA requirements, and is approved by Underwriters' Lab., Inc. Features of this quality welder include a stepless current regulator for any desired

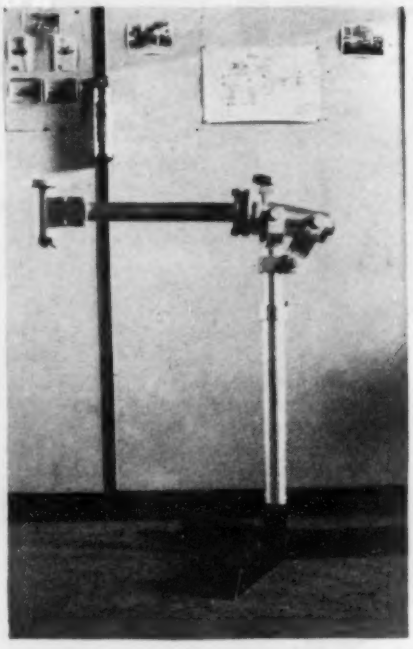


amperage from 20 to 150 amp.; a compact, portable unit measuring 18¼ x 26 x 38½ in., and heavy duty construction throughout assuring long, trouble-free performance.

The Conco A.-C. Portable Welder uses 50 to 70% less power than many other types and plugs into any 230-v. 60-cycle outlet. This practical welder with a wide range of from 20 to 150 amp. can be used for cutting, welding, brazing and soldering. Full information and specifications may be obtained by writing to Conco Engineering Works, Mendota, Ill.

UNIVERSAL BALANCED POSITIONER

The Aronson Machine Co. of Arcade, N.Y., has developed a new positioner for the welding industry. By the use of universal balancing the operator can, by making slight adjustments, reach at the center of gravity of most any size or shape of material, and with the pressure of one finger can move this piece of equip-



ment to any infinitely variable angle—360° rotation on three axes: the head axis or swivel plate, the spindle axis or work plate of 6 in. diameter and the pedestal axis. There is also on the three axes positive locking in any position merely by a twist of the wrist. On two axes, the Head and Spindle, there are friction nuts designed to give the operator any amount of friction desired to snug up on that particular rotation. This frictional adjustment tightens against the grounding rings in the head and spindle and also on the Timken Taper Roller Bearings located at these two points.

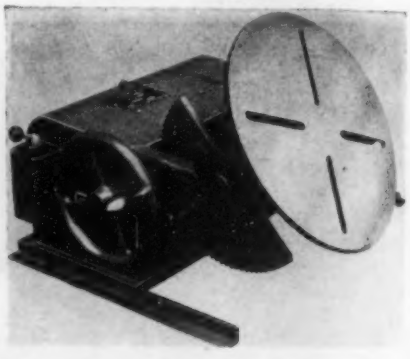
In conjunction with the two sizes positioners, the models A200 and A500 with 200- and 500-lb. capacities, respectively, the Aronson Machine Co. has developed the Universal Holding Fixture that will take material to 4 ft. diameter with interchangeable set-screw type clamps or toggle (fast action) clamps. The holding fixture also includes a vise which mounts in the center of the fixture or on the work table of the positioner. The vise jaws are synchronized to keep the work centered at any opening.

Also in the positioning line there will, very shortly, be included the air-powered model of the two above-mentioned models.

The positioners and the holding fixtures working in conjunction with each other will solve most any positioning problem at a minimum in cost.

POWER-OPERATED BENCH MODEL 1-P POSITIONER

A power-operated bench model positioner for work weighing 100 lb. or less is Ransome's answer to increased demands for a faster, more efficient tool for positioning small work in shops and educational and industrial laboratories. Built to handle small units, the Model 1-P is a versatile machine that facilitates welding assembling, repairing, grinding, hard sur-



facing and similar operations for positioning the work to the best advantage for the operator. Work may be tilted to 135° and locks in any position at any degree of tilt. It may also be revolved 360° by a 1/8-hp. single-phase reversible motor. A disengaging clutch permits free wheeling when desired. Lever-operated vari-drive pulley permits a speed range from 0.21 to 5 rpm.

Ransome manufactures welding and work positioners from 100-lb. hand- and motor-operated to 40,000 motor-operated, as well as turning rolls and other special positioning equipment. For further information, write the Industrial Division, Ransome Machinery Co., Dept. P-94, Dunellen, N. J., a subsidiary of Worthington Pump & Machinery Corp.

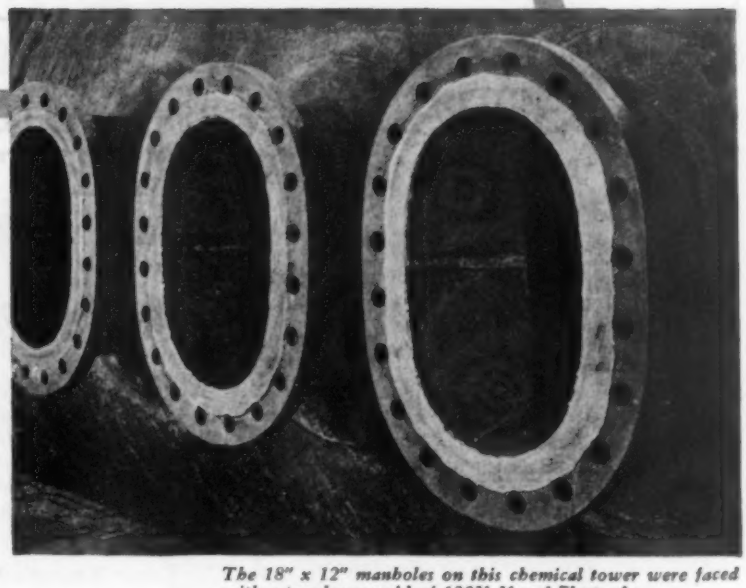
AMPCO ISSUES WELDING PROCEDURES FOR IRON

How to weld malleable iron and cast iron is fully described in two new procedure sheets recently issued by Ampco Metal, Inc., Milwaukee 4, Wis., and featuring the use of Ampco-Trode coated aluminum bronze electrodes and Phos-Trode shielded arc phosphor-bronze electrodes.

The sheets cover the recommended electrode for each type of iron, polarity and current, recommended amperage and voltage, preparation, preheat if necessary, and the procedure necessary for successful welding with these bronze electrodes.

Copies of these sheets will be sent on request without obligation to interested welders.

How to put
NICKEL, MONEL and INCONEL OVERLAYS
on Steel and Iron



The 18" x 12" manholes on this chemical tower were faced with a two-layer weld of 130X Monel Electrode.

IF new surfaces must be made wear and corrosion resisting... If worn or corroded surfaces must be rebuilt... you can do the job right with Nickel Alloy overlays.

INCO Nickel Alloy overlays on steel and iron parts can be divided into two common kinds.

The *first* is usually found in chemical and process equipment where Monel*, "K" Monel*, Nickel or Inconel* overlays are used to prevent corrosion. In general, these overlays are applied to flanges and nozzle faces, and are used with a separating gasket.

The *second* kind is used on valve parts needing corrosion-resisting surfaces for their metal-to-metal contacts.

For overlays that use gaskets, here are the steps:

First, make sure the surface to be overlaid is clean. All oil, grease, oxide and dirt must be removed.

Then, take a 1/8" 130X Monel or a 134 "K" Monel electrode and put down the first layer. Just make the amperage high enough to get the proper arcing. Smart operators use a fairly fast weave to cut down penetration of the Monel into the base metal.

For the second and third layers, use 5/32" to 1/4" electrodes. The size will depend upon the thickness of the base metal and the area to be covered.

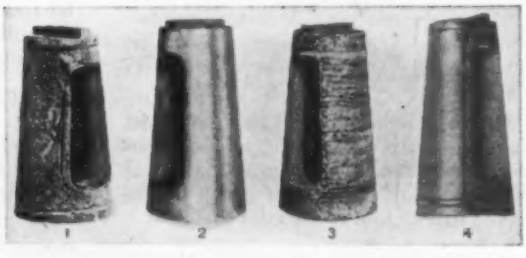
Naturally, any welder worth his spark will be sure to remove all slag before each pass.

When you're applying overlays on valve parts, you want to make sure that no cracks occur. Cracks mean possible leaks! (With gasketed surfaces, of course, fine *checks* make no difference. The gasket will seal them.)

For overlays on valve parts, here are the steps:

Clean your surface. Then, put down the first layer with a 1/8" 131 Nickel electrode using 100 to 110 amps. Make your weave fast and fairly wide. You want to limit penetration into the base metal.

Once you've put down the first layer of Nickel, you're ready for the next layers of Monel, "K" Monel or Inconel. Put these on in the regular way, using an electrode of the right diameter for the job. Or, if you continue with Nickel, put them on just like the first layer.



Step-by-step photos show how cast steel valve plugs (Used in corrosive service) were made better than ever... 1. Corroded plug... 2. Plug machined down for the overlay... 3. Overlay built up with 130X Monel Electrode... 4. Machined, ground and lapped plug ready for service again.

Beads can be put on in any direction, but it's better if they're applied in the long direction of the overlay. Narrow, string beads are better than wide, weaving beads.

Make each stringer overlay the previous bead by about 50 per cent. Peening of the overlays is not necessary.

And, if you want to keep your friends in the machine shop, you'll be careful to put on enough metal *(but not too much)* to make machining easy.

Some shops get a lot of overlay jobs. Some never get a one. A plant maintenance man, though, will find plenty of times when he can salvage worn or corroded iron and steel equipment, and make them even better than new with Nickel Alloy overlays.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y.

NICKEL (INCO TRADE MARK) **ALLOYS** MONEL* • "K" MONEL* • "KR" MONEL* • "R" MONEL* • "S" MONEL* • INCONEL* • NICKEL • "L" NICKEL* • "Z" NICKEL*

*Reg. U. S. Pat. Off.

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ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington 25, D. C.

2,414,834—WELDING TIP POLISHER—Chalmers H. Randolph, inventor, St. Paul, Minn., assignor to Minnesota Mining & Manufacturing Company. (3 Claims)

The polisher has an anvil member adapted to be mounted between two mounted welding tips and an abrasive tape is provided to be led between the anvil and the welding tips.

2,414,873—MULTIFLAME WELDING APPARATUS—Harry T. Herbst, inventor, Elizabeth, N. J., assignor to Union Carbide and Carbon Corporation. (7 Claims)

Herbst's welding head has an inlet chamber that is divided into sections by a pressure reducing member and a pair of outlet chambers each of which is connected to a section of the inlet chamber.

2,414,874—WELDING—Harry T. Herbst, inventor, Burlingame, Calif., assignor to Union Carbide and Carbon Corporation. (6 claims)

This patent relates to U. S. Patent 2,414,873 and covers a welding method involving use of oxyacetylene high velocity preheat flame jets and low velocity welding jets. The oxyacetylene ratio of the preheat flame jets is oxidizing and that of the welding flame jets is neutral.

2,414,878—OXYGEN VALVE FOR CUTTING TORCHES—Howard G. Hughey, inventor, Fanwood, N. J., assignor to Air Reduction Company, Incorporated. (4 Claims)

The valve has a valve element arranged to close in the direction of fluid flow, biasing means to retain the valve element on its seat and means for moving the valve element off its seat. Special means are provided to render the action of the valve element is dependent of the inlet fluid pressure.

2,414,905—WELDING MACHINE—Clifford S. Seltzer, inventor, Warren, Ohio, assignor to The Taylor-Winfield Corporation. (10 Claims)

This patent to Seltzer covers an automatic machine for welding metallic articles to the side walls of tubular metallic bodies. The metallic bodies are moved in step by step progression along a predetermined path which includes welding dies that engage the bodies.

2,414,970—CHAIN WELDING APPARATUS—Lionel D. Morelle, inventor, Shrewsbury, Mass. (4 Claims)

The welding apparatus has slides movable transversely of a frame, and a rotatable chain holder on the slides. A plurality of welding means are carried by the frame.

2,415,052—ELECTRIC WELDING HEAD—Eric Sugden Waddington, inventor, London, England, assignor to The Hartford National Bank and Trust Company. (7 Claims)

In this patent, a frame member is rotatably positioned within a support, and electrode holders are adjustably positioned on the frame member.

2,415,149—ARC WELDING ELECTRODE—Per Yngve Sjoman, inventor, Gothenburg, Sweden, assignor to Elektriska Svetsningsktiebolaget, Gothenburg Sweden. (2 Claims)

This patent covers an electrode flux coat with the composition of SiO_2, 23 to 50%; $Al2O_3$, zero to 5%; FeO from metallic iron, 2 to 11%; FeO from iron compounds, 14 to 25%; CO_2 from carbonate, 8 to 17%; MnO from metallic manganese, 22 to 49%; and Na_2O, 1 to 4%.

2,415,532—ELECTRIC WELDING CURRENT CONTROL—Lawrence J. Puls, inventor, Custar, Ohio. (8 Claims)

The patented control is for use with a generator having field poles and a rotor, and it includes an additional field pole intermediate a pair of other field poles and provided with a spring that normally retains such additional pole spaced from the rotor. The added pole has a coil, in circuit with the welding electrode, the magnetic flux from which acts to move the extra pole toward the rotor against the action of the spring responsive to the action of the welder in modifying the position of the extra pole with relation to the rotor.

2,415,573—WELDED STRUCTURE—Comfort A. Adams, Philadelphia, Pa., and Harold A. Strickland Jr., Detroit, Michigan, inventors, assignors to The Budd Company. (3 Claims)

The welded structure has plural overlying parts welded together by locally applied high currents to form nuggets. The transition surfaces of the welds have pronounced concave contours forming spaced peaks between which anchoring masses of unmodified metal intervene.

2,415,671—ELECTRODE HOLDER—Charles Camilleri, inventor, Detroit, Michigan, assignor to Bordon Mfg. Co., Inc. (17 Claims)

In this holder, an auxiliary clamping jaw is pivotally mounted on a handle in association with a fixed clamping jaw. A spring urges the auxiliary clamping jaw into clamping association with the other jaw and one end of the spring is positioned by means of a cable connector that is received in the handle.

2,415,708—WELDING METHOD AND APPARATUS THEREFOR—David Sciaky, inventor, Chicago, Ill., assignor to Welding Research, Inc. (22 Claims)

Sciaky's patent covers a method for obtaining a balanced loading on a multiphase a.-c. supply wherein the a. c. is rectified and applied to the primary of a welding transformer. The direction of current flow is reversed for each impulse so as to produce an alternating current in the secondary which is connected to the workpiece for welding same.

2,415,778—ELECTRODE HOLDER—Russel A. Welch, inventor, Detroit, Mich. (9 Claims)

Welch's holder has a tubular insulator handle having internal ribs which nest with ribs on a conducting terminal. A conducting head with an insulating cap thereon is adjustably secured to the terminal.

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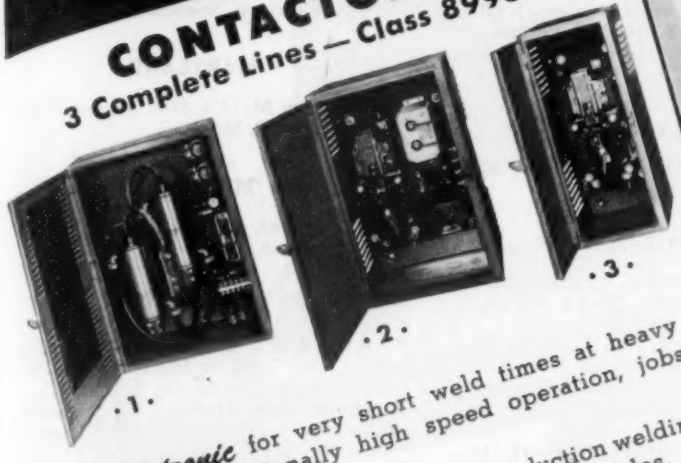

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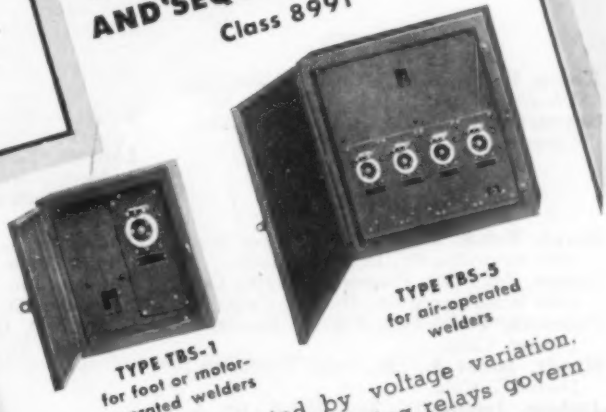

TYPE TBS-1 for foot or motor-operated welders

TYPE TBS-5 for air-operated welders

Timing not affected by voltage variation. Individual pneumatic timing relays govern each step in the welding sequence.

COMBINATION CONTROLLERS
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Write for Bulletins 8990, 8991 and 8992. Address SQUARE D COMPANY, 4041 N. Richards Street, Milwaukee 12, Wisconsin

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Peterson, Arthur W. (C), 193 Locust St., Attleboro, Mass.

BRIDGEPORT

Mitchell, James R., Jr. (C), 245 Wakelee Ave., Ansonia, Conn.
Pataky, Arthur (C), 318 Spruce St., Bridgeport 5, Conn.

CANADA

Salbaing, Pierre A. (B), Canadian Liquid Air, Ltd., 1111 Beaver Hall Hill, Montreal, Que. Canada.
Volff, Mr. (B), Canadian Liquid Air, Ltd, 1111 Beaver Hall Hill, Montreal, Que., Canada.

CLEVELAND

Knapp, Everett E. (B), Chardon Welding, Chardon, Ohio.
Schwartz, Albert (B), Howes Iron Wks., Cleveland 5, Ohio.

COLORADO

Brown, Nelson A., (B), M. L. Foss, Inc., 7901 Arapahoe St., Denver 1, Colo.
Couper, John (B), Couper Retinning Co., 4492 Washington St., Denver, Colo.
Donmyer, Philip (C), 2137 S. Sherman, Denver, Colo.
Hynds, James A., (B), 1410 Dahlia St., Denver 7, Colo.
Juchem, James (B), Box 188-A, Rt. 8, Lakewood, Colo.
Lambrecht, Steve J. (C), 920—33rd St., Denver, Colo.
Lindquist, Harold J. (C), 680 S. Dale Ct., Denver, Colo.
Longo, Phillip (B), Longero Boiler & Sheet Iron Wks., 3410 Brighton Blvd., Denver, Colo.
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Rodda, Spraque (B), 8965 W. 20th Ave., Denver 15, Colo.
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Smart, William H. (B), 3101 S. Pearl St., Englewood, Colo.
Wondrak, Karl E. (B), 115 S. Dale Ct., Denver, Colo.

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Bowers, Robert A. (C), Williams & Co., Inc., 31 N. Grant Ave., Columbus, Ohio.
Dasher, Leon Marshall (C), Williams & Company, Inc., 31 N. Grant Ave., Columbus 15, Ohio.
Gallenstein, R. L. (C), Williams & Co., Inc., 31 N. Grant Ave., Columbus, Ohio.
Hoefler, Joe (C), 143 N. Warren Ave., Columbus 4, Ohio.
Mirolo, Peter (C), 1369 Elmwood Ave., Columbus 8, Ohio.
Reid, H. F. (C), Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio.
Reynolds William E., (C), Aluminum Co. of America, 12 N. Third St., Columbus, Ohio.

DAYTON

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DETROIT

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Fridwall, Frederick A. (C), 20523 Gaukler St., St. Clair Shores, Mich.
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Hopper, Ottis (C), 19271 Moenart, Detroit 12, Mich.
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Kirk, Wm. (C), 201 N. Broadway, Escondido, Calif.

MAHONING VALLEY

Cook, Harry W. (C), 438 Ohio Edison Bldg., Youngstown, Ohio.
Wangsjo, Hans J. U. (C), A. B. Asea Svetsmaskiner, Stockholm 20, Sweden.

MARYLAND

Griffin, Paul M. (C), 5107 Midwood Ave., Baltimore 12, Md.

MICHIANA

Pryatel, Frank J. (C), 1217 S. Walnut, South Bend, Ind.

MILWAUKEE

Albers, Edward John (C), Allis-Chalmers Mfg. Co., Tank & Plate Shop, 1126 S. 70th St., West Allis 14, Wis.
Kutchera, Don Henry (C), Kimberly-Clark Corp., P. O. Drawer 432, Neenah, Wis.
McCarthy, William A. (C), 2362 S. 58th St., Milwaukee 14, Wis.
Winkelman, Richard (C), 1224 Lisbon Ave., Hartland, Wis.
Zunke, W. F. (C), R. R. 5, Box 284, Waukesha, Wis.

NEW JERSEY

Lewis, Douglas R. (C), Process & Equipment Dev. Corp., 20 Clinton St. Newark 2, N. J.
Murray, Glen A. (C), The Linde Air Prods. Co., Rm. 502, 300 Madison Ave., New York 17, N. Y.

NEW YORK

Corkindale, A. D. M. (C), 37 Brompton Rd., Great Neck, L. I., N. Y.
Henry, Otto H. (C), Polytechnic Institute of Brooklyn, 85 Livingston St., Brooklyn, N. Y.
Hutchinson, Frank D., Jr. (C), Midwest Piping & Supply Co., Inc., 30 Church St., New York 7, N. Y.

NORTHERN N. Y.

Snyder, Richard C. (B), 44 Union St., Amsterdam, N. Y.

NORTHWEST

Butterfield, Harvey W. (C), 2401 Harriet Ave., So., Apt. 1, Minneapolis 5, Minn.
Doucet, Floyd J. (C), Sorensen Co., 1049 Raymond Ave., St. Paul 8, Minn.
King, Phillip A. (C), 3924 16th Ave., So., St. Paul 4, Minn.
Lundberg, Milton A. (C), 5232 46th Ave., So., Minneapolis 6, Minn.
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Hoffman, David L. (C), 502 Kerr St., Titusville, Pa.
Huston, Robert J., Jr. (C), Air Reduction Sales Co., 730 Grant St., Buffalo, N. Y.
Johnson, Stanford D. (C), 319 N. Washington St., Titusville, Pa.
Marsh, William M. (C), P. O. Box 152, Rouseville, Pa.
Williams, S. V. (B), Struthers Wells Corp., Titusville, Pa.

OKLAHOMA CITY

Luster, Jimmie (C), 1031 N. Harris, Oklahoma City 7, Okla.

PEORIA

Weber, Henry L. (B), 16 Glendale Rd., Rantoul, Ill.

PHILADELPHIA

Alderfer, Titus F. (B), Souderton Welding Service, 110 S. Front St., Souderton, Pa.
Brown, Marshall H. (B), Engrg. Res. Lab., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Cullen, Dorsey H. (C), Hobart Welder Sales Co., 401 N. Broad St., Philadelphia 8, Pa.
Grow, Oliver W. (C), 535 E. Gates St., Philadelphia 28, Pa.
Pfeffer, Harry M. (C), Drexel Institute of Technology, Mechanical Engrg. Dept., Rm. 6, 32nd & Chestnut Sts., Philadelphia, Pa.
Rozental, David (C), 3604 Spring Garden St., Philadelphia 4, Pa.
Stintz, Frederick R. (B), 342 Albany Ave., Barrington, N. J.
Van Sciver, Herbert Doane, II (C), 417 Merion Pl., Merion Sta., Pa.

PITTSBURGH

Graham, D. W. (B), Heyl & Patterson, Inc., 55 Water St., Pittsburgh, Pa.
Lytle, Martin H. (B), Aliquippa Welding Service, 2320 Sheffield Rd., Aliquippa, Pa.
McConahy, Myrel P. (B), R. D. 1, New Castle, Pa.
Rochez, Alex (B), Rochez Bros. Specialty Steel Prod. Co., 1560 Electric Ave., East Pittsburgh, Pa.
Webb, C. Earl (C), American Bridge Co., Frick Bldg., Pittsburgh, Pa.
Yang, Johnson C. (C), 7137 Penn Ave., Pittsburgh, Pa.

PORTLAND, ORE.

Miller, Francis P. (B), 7306 S. E. Raymond St., Portland 6, Ore.

PUGET SOUND

Bennett, Edward E. (C), The Linde Air Prods. Co., 2901 First Ave. So., Seattle, Wash.
Espen, Raymond H. (B), 1731 Harding St., Enumclaw, Wash.
Gunnels, Randall H. (B), 8649 17th S. W., Seattle 6, Wash.

ROCHESTER

Barreca, Russell J. (C), The Pfaudler Co., 89 East Ave., Rochester, N. Y.

ST. LOUIS

Hannon, Howard (C), Hannon Machine Wks., West Union, Ill.
Stogsdill, Tom E. (C), 1923 Agnes St., St. Louis, Mo.

SAN FRANCISCO

Bernheim, Edgar (C), 1560 Alice St., Oakland, Calif.
Darcey, Thomas R. (B), National Cylinder Gas Co., 439 Bryant St., San Francisco 7, Calif.
Humphreys, C. W. (C), Metal & Thermit Corp., E. Grand Ave., South San Francisco, Calif.
Parker, Earl R. (B), Mining Bldg., Univ. of Calif., Berkeley 4, Calif.
Thylin, Elmer C. (C), Metal & Thermit Corp., E. Grand Ave., South San Francisco, Calif.

SYRACUSE

Cary, John (C), 609 Kirkpatrick St., Syracuse 8, N. Y.
Green, Raymond V. (C), R. D. 1, Fulton, N. Y.
Knaple, William J. (B), 156 S. Midler Ave., Syracuse, N. Y.
Mackey, Roy (C), R. F. D. 1, Liverpool, N. Y.

TIDEWATER

Guarda, Lt. Hugo (B), Norfolk Naval Shipyard, B.O.Q. Rm. 59, Portsmouth, Va.
McVey, Hector (C), 3 Geo. Washington Hwy., Portsmouth, Va.

WASHINGTON

Kennedy, Clarence S. (C), 495 H St., S. W., Washington 4, D. C.

WESTERN NEW YORK

Pierson, Ellsworth A. (C), Niagara Alkali Co., P. O. Box 352, Niagara Falls, N. Y.
Slater, Jean Bert (B), 140 Forest Dr., Orchard Park, N. Y.
Wagner, Joseph (B), Ace Welding Co., 1087 Genesee St., Buffalo, N. Y.
Whitmore, Charles F. (B), Harrison Radiator Div. GMC, Washburn St., Lockport, N. Y.

WICHITA

Hamby, Preston W. (C), 323 Broadway, Augusta, Kans.
Patton, B. E. (C), B & G Mfg. Co., 338 S. Emporia, Wichita, Kans.

WORCESTER

Bek, Stephen (B), 89 Federal Hill Rd., Oxford, Mass.
Derby, Philip E. (B), 61 Lincoln St., Spencer, Mass.
Koski, Frank M. (C), 21 Hillside St., Worcester, Mass.
Viner, Charles G. (B), Charles G. Viner & Co., 133 Central St., Worcester, Mass.
Welsh, James E., Jr. (C), Reservoir St., Holden, Mass.

NOT IN SECTIONS

Abshier, John A. (D), Rt. 2, Siloam Springs, Ark.
Galyan, Turner (D), Rt. 4, Siloam Springs, Ark.
Hanson, J. H. A. (B), The Dunlop Rim & Wheel Co., Foleshill, Coventry, England.
Langhoff, Ing. Sigurd (B), % O. Y. Troili A. B., 12, S. Esplanadgatan, Helsingfors C.-Finland.
Slocum, G. A., Jr. (B), 201 Agalea Circle, Spring Hill, Ala.
Summerville, A. D., Jr. (C), Summerville Garage, 319 N. Linam, Hobbs, New Mex.

Members Reclassified

During Month of February

BOSTON

Adams, Ernest N. (C to B), 192 Chandler St., Worcester, Mass.

DAYTON

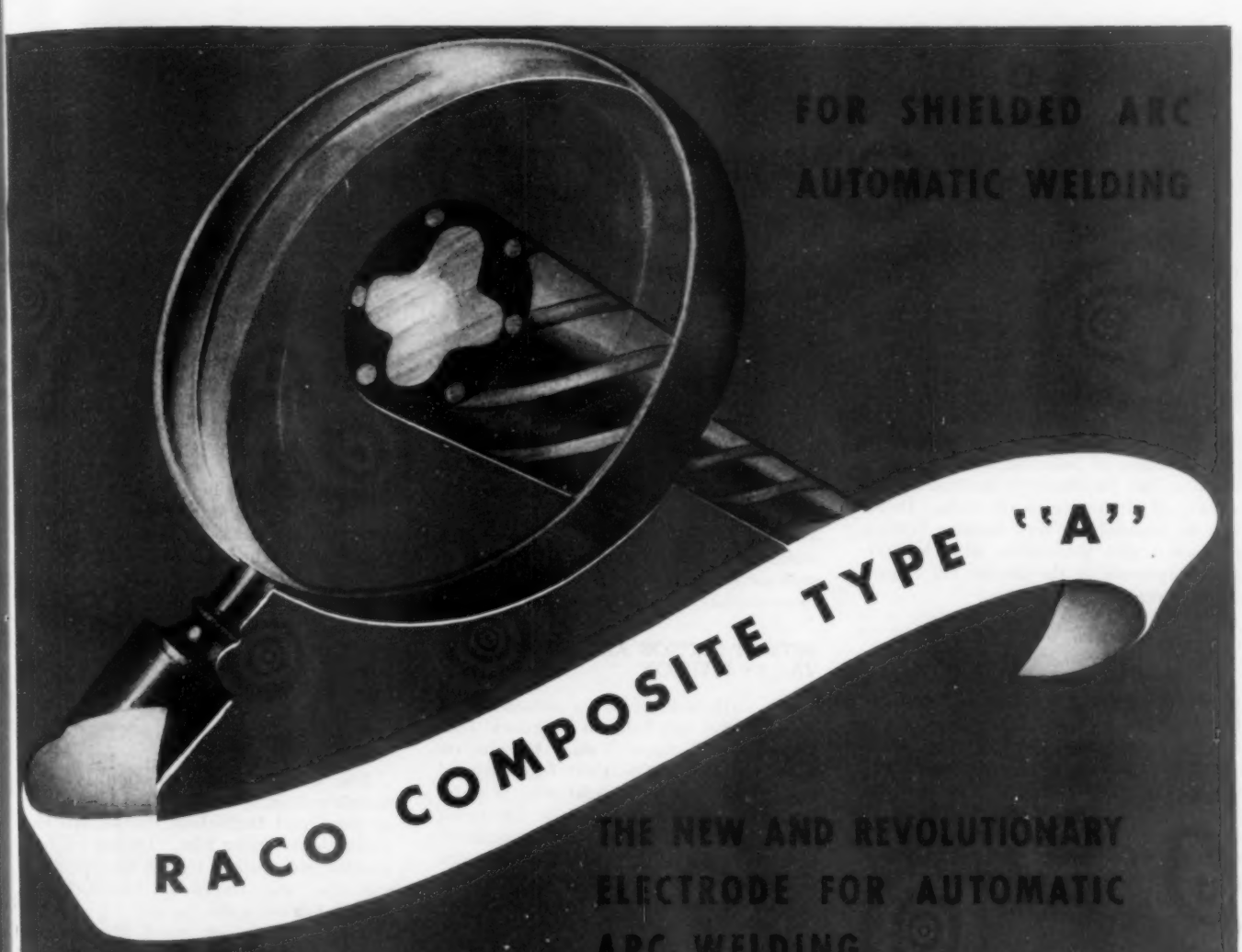
Rehse, Frank H. (B to C), 4 Shoop Ave., Apt. 3, Dayton, Ohio.

NORTHWESTERN PA.

Jewell, R. L. (B to C), American Sterilizer Co., Erie, Pa.

SAN FRANCISCO

Bradley, R. B. (C to B), 1020 Jones St., San Francisco, Calif.



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SECTION ACTIVITIES

CHICAGO

The February meeting of the Chicago Section was held on the 21st at People's Gas, Light and Coke Co. Auditorium. Dinner was at Burke's Grille and Restaurant. Subject of the technical meeting was "Controlled Atmosphere Brazing." The speaker was Lawrence Jacobsmeyer, General Manager of Salkover Metal Processing Co. Mr. Jacobsmeyer has had a wide variety of experience in this field. In his talk he pointed out how furnace brazing in a controlled atmosphere may be used advantageously in the production of precision parts.

CINCINNATI

A very interesting plant inspection of the Vulcan Copper & Supply Co., followed by a fine steak dinner at the Engineering Society headquarters, was held on February 25th. Vulcan Copper & Supply Co. is engaged in the welding of copper, stainless, nickel, Everdur and other metals in that line. Welding procedures in the manufacture of equipment for chemical process industries were inspected.

CLEVELAND

A. F. Chouinard, Manager, Research and Development Department, National Cylinder Gas Co., Chicago, spoke at the regular monthly meeting held on March 12th. His topic, "Applications of Oxy-Acetylene Flame Hardening," covered the basic metallurgy encountered in flame hardening and Mr. Chouinard pointed out the tremendous number of flame-hardening applications which are practical today.

As coffee talker, Carl J. Schroeder, foreman of the underground department at Cleveland Electric Illuminating Co., and a founder of the Cleveland Section, discussed his hobby, "Philatelistics." Mr. Schroder has a remarkable collection of rare United States stamps and coins.

COLORADO

Dinner meeting was held on February 11th at the Oxford Hotel, Denver. J. H. Cooper, Sales Engineer, Taylor-Winfield Corp., spoke on "Unusual Resistance Welding Jobs." A film "This Is Resistance Welding" was shown through the courtesy of the General Electric Co. Resistance welding is almost a new subject for this territory; the turn-out surely indicated that many were interested in getting new ideas. All considered the meeting well worth while.

DAYTON

John J. Vreeland Metallurgical Engineer in charge of Welding Sales and Service of the Chase Brass and Copper Co., was the guest speaker at the February 26th meeting held at the Engineers' Club. His topic "Welding of Copper and Copper Alloys" was of particular interest to this section.

On April 23rd the speaker will be A. M. Unger, who is associated with the Pullman-Standard Car Co. of Chicago. He is a nationally recognized authority on all types of welding and will speak on "Resistance Welding." One of his recent accomplishments was the design of a resistance welder at Pullman-Standard which welds four railroad car side sections simultaneously and another which welds two complete tops in one operation.

DETROIT SECTION AND SAGINAW VALLEY DIVISION

The sixth meeting of the season of Detroit Section was held on February 14th and of the Saginaw Valley Divison on February 13th. The First International "Quiz the Experts" Night was held by the Detroit Section on the 14th. Chairman was L.W. Delhi, President of the AMERICAN WELDING SOCIETY. Experts from the Toronto Section, Canadian Welding Society, were R. M. Gooderham, J. S. Fullerton, W. A. Amos and W. J. Nicholls. Experts from the Mahoning Valley Section A.W.S., were E. A. Mallett, R. Hass, R. Poole and R. Fisher. Experts from the Cleveland Section, A.W.S., were E. R. Benedict, A. L. Pfeil, R. E. Kinkead and H. H. Dyar. Experts from the Detroit Section, A.W.S. were T. J. Crawford, Foster Woodward, Don Corey and C. B. Welcomb. This is the most popular type of meeting held by the Detroit Section.

The Saginaw Valley Division had as its speakers Spencer Hinds and Frank DaRoza, of the Weltronic Corp., who spoke on "Resistance Welding Control Devices."

The seventh meeting of the season was held on March 14th by the Detroit Section and March 13th by the Saginaw Valley Division.

M. L. Van Dagens, Staff Executive, Chrysler Corp., presented a nontechnical talk on "Ceiling Unlimited." Mr. Van Dagens is a specialist in human relations and has the engineering viewpoint. His talk included suggestions on relations with fellow workmen, employers or employees.

HARTFORD

A dinner meeting was held on February 20th at the University Club of Hartford. H. S. Swan, General Welding Supervisor, American Locomotive Co., presented an address on "Welding the Modern Steam and Diesel Locomotive."

INDIANA

Leon C. Bibber, Welding Engineer for the Carnegie-Illinois Steel Corp., was the guest speaker at the February 28th meeting held at Buckley's, Cumberland, Ind. Mr. Bibber's subject "The Elements of Welded Design," dealt with the various elements of design, such as doubler plates, box girders, joinings of weldments to castings, proper and improper connections, joints, etc.

KANSAS CITY

The meeting on February 13th was opened by a dinner at Harveys. Technical meeting was held at the Kansas City Power and Light Building. J. H. Cooper, of Taylor-Winfield Corp., gave a very interesting talk on "Resistance Welding," also a film produced by General Electric on the same subject showing some very interesting applications of resistance welding in production.

LEHIGH VALLEY

The Lehigh Valley Section held its monthly meeting on Monday, March 3rd, at the Hotel Bethlehem, Bethlehem, Pa. A new sound color film, "Design for Arc-Welded Structures," by the Lincoln Electric Co., was shown to members and guests, following the dinner.

The guest speaker was J. H. Humberstone, Vice-President of the Arcrods Corp. Mr. Humberstone spoke on "A New Field of Electrode Development." He discussed the harmful effects of hydrogen which involves consideration during present and future activity in the field of electrodes. He descibed these effects, the source of the hydrogen and present trends in the development of electrodes which will minimize the difficulties experienced in the past.

MAHONING VALLEY

M. J. Wohlgemuth, Asst. Manager of Central Engineering and Service Dept., Westinghouse Electric Corp., addressed the February 18th meeting held in the Westinghouse Auditorium, Sharon, Pa., on his experiences in Russia. Although the subject did not embrace the welding arts, the speaker's discussion of experiences in building a steel mill in Central Siberia were highly interesting to all.

MARYLAND

The February 21st meeting was held at the Baltimore Engineers' Club. Dinner was followed by a showing of the Lincoln Electric Co.'s new film, entitled "Design for Arc-Welded Structures."

The technical session featured a talk by John R. Morrill, Asst. to the Vice-President, The Lincoln Electric Co., entitled "Imagination—The Key to Automatic Welding." Slides were presented to illustrate this talk which were both interesting and informative.

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The operator of this traveling resistance-welder at the Pullman Standard Car Manufacturing Co., gets consistent welds automatically

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In welding these cars, two spot welds are made at a time, the spacing between the two varying in accordance with the dimensions of the parts and the strength specifications. As the spacing varies, the length of the secondary circuit changes, and in turn the current is changed.

Where formerly this shift meant frequent readjustments by the operator, guided by an extensive table of machine settings, now just one of two settings is needed, depending on whether the machine is welding Cor-Ten or stainless steel; the current regulator does the rest.

This regulator holds current within plus or minus 2 per-cent of normal, whereas, the unregulated current might vary as much as plus or minus 20 per-cent.

Even when space is uniform, current is affected by varying amount of magnetic material in current loop.

IMPROVES QUALITY

In this, and other applications such as welding propeller blades, metal barrels, etc., this regulator provides uniform quality welds when more or less metal is introduced in the welder throat.

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The same settings can be used when operating a press-type spot welder, a gun welder connected to the same transformer, or when welding magnetic materials with a press-or gun-type welder.

The current regulator is specially designed for use with G-E electronic resistance welding controls which include heat control by the phase-shift method.

For additional information ask our nearest local office for Bulletin GEA-4220. *Apparatus Department, General Electric Company, Schenectady 5, N.Y.*

GENERAL ELECTRIC

An average attendance of better than 95% is the record being established at the Maryland Section's Educational Lecture Series currently being conducted at the Johns Hopkins University.

MICHIANA

The Michiana Section held their February meeting on the 21st at the Bendix Legion Hall in South Bend. The subject of the meeting, "The Use of Welding in Tool Maintenance," was presented by P. M. Perry of the Perry Welding Sales & Service Co., South Bend. The talk was illustrated with slides. Mr. Perry presented a method of determining what type of electrode to use, discussed the types of welding suitable for tool and die work, and ended with a short paper on the much-needed but highly fictional wooden arc-welding electrodes.

MILWAUKEE

The regular monthly meeting of the Milwaukee Section was held at the Ambassador Hotel on Friday, February 28th, with a crowd on hand that taxed the capacity of the hall. As an after dinner feature a half-hour movie of the Russian People was presented and well received.

The technical talk was by R. F. Wyer, Application Engineer, General Electric Co., Schenectady. His topic was "Three Gas-Shielded Arc-Welding Processes—Atomic Hydrogen, Helium, Argon." Mr. Wyer spoke with only a few notes for a guide besides his slides. The talk was very effectively presented and many favorable commendations were heard afterward. The discussion lasted long after the meeting broke up.

NEW JERSEY

The regular monthly dinner meeting of this Section was held on Tuesday, February 18th, at the Essex House, Newark, A. M. Setapen, Manager, Engineering Division, Handy & Harman, presented the technical paper on "Low-Temperature Silver Alloy Brazing." An interesting discussion followed.

NEW YORK

For their February meeting, held on the 28th, the New York Section were guests of the Metropolitan Section of the Society of Naval Architects and Marine Engineers, at the Columbia University Club. The meeting was preceded by a buffet supper.

The speaker of the evening was Norman L. Mochel, Manager of the Metallurgical Engineering Dept., Westinghouse Electric Corp. He spoke on "Welding of Marine Machinery" and illustrated his talk with slides, In his talk Mr. Mochel described some of the uses of welding in marine machinery prior to 1936 and then showed the rapid advances in the use of welding for this work in the "defense" and war periods following 1936. Mr. Mochel's talk aroused considerable interest and provoked a number of questions at its conclusion.

NORTHWEST

A dinner meeting was held on February 5th at the Curtis Hotel, Minneapolis. A special meeting of executives and officers was held before the meeting and Geroge N. Sieger, Second Vice-President of the Society, gave a very interesting report and offered some very constructive suggestions to improve the local Section.

One hundred and ten members and guests attended the meeting and Mr. Sieger gave a short talk on "Scope and Activities of the Society." James W. Owens, Director of Welding, Fairbanks, Morse and Co., Beloit, Wis., gave a very interesting talk on "Welding and Flame Cutting."

NORTHERN NEW YORK

The February meeting of the Northern New York Section was held at the Mohawk Hotel on the 27th, with F. E. McAtee, Chicago Bridge & Iron Co., as speaker. Mr. McAtee gave an illustrated talk on the safety of large field welded pressure vessels, outlining the principles of field erection of large spherical pressure vessels, and outlined recent developments which have been made in improving the strength of such tanks. At the dinner preceding the meeting, F. W. Davis, Vice-President of the New York-New England District, gave a brief talk in which he urged the membership to concentrate on bringing more members into the northern New York Section.

PHILADELPHIA

H. F. Swan, Welding Supervisor, American Locomotive Co., was the speaker at the February 17th meeting held at the Engineers' Club. Mr. Swan's subject, "Welding of Diesel and Steam Locomotives," was well received.

The Sixth Panel Discussion Group Meeting met on Friday, March 7th, at the Engineers' Club, Junior Room. L. J. Cogan, Graver Tank & Manufacturing Co., led the discussion on the subject "Welding Inspectors and Inspection of Weldments."

PITTSBURGH

Dinner at the Hotel Webster Hall preceded the meeting on February 19th in the Mellon Institute of Industrial Research Building. Dr. A. B. Kinzel, Vice-President of the Union Carbide & Carbon Research Labs., gave one of the best papers presented before this Section on the subject of "Pressure Welding." A film "Adventures in Research," was presented by Phillips Thomas of the Westinghouse Corp.

PORTLAND, OREGON

The October 15 1946 meeting was held at the Mallory, Hotel. Prof. A A Knowlton, Head of the Department of Physics, Reed College, presented a very educational but highly technical subject "Atomic Energy."

The November 26th meeting had a Coffee Talk by Earl Sears of State Safety Council on "Safety and Its Practices." Two films were shown through the courtesy of the General Electric and Lincoln Electric companies.

The December 19th meeting at the Transportation Club had as dinner speaker Earl Flynn, who spoke on "Romance of the Air" and gave a Liquid Oxygen Demonstration, which was very interesting and well received.

The January 22, 1947 meeting was held in the Executive Dining Room, Swan Island Yard. A movie was shown through the courtesy of the Pacific Chain Manufacturing Co. L. W. Delhi, President of the Society, gave an outline of Society outlook and its policies.

ROCHESTER

The regular monthly meeting of the Rochester Section was held on March 10th at the Powers Hotel. A Coffee Talk was given by Colonel Ward Hamilton on his interesting experiences in running the railroads in Korea.

The speaker was K. L. Hoff of the Eutectic Welding Alloys Corp., who spoke on "Recent Developments in Low-Temperature Welding." There was also a demonstration of low-temperature welding after the talk.

SAINT LOUIS

The meeting of this Section was held on February 13th at the Engineers' Club Auditorium. The meeting was attended by approximately 200 People. W. J. Jackel, of the A. O. Smith Corp., delivered a fine treatise on the subject "Multilayer Construction of Pressure Vessels."

SAN FRANCISCO

The February meeting was held on the 24th at the Engineers' Club. E. L. Mathy presented an excellent talk on the Western Metal Congress. Prof. E. Paul De Garmo, of the University of California, gave an excellent address on "Some Tests of Large Welded Structures."

SOUTH TEXAS

The February 27th meeting was held in the Chamber of Commerce Building. R. D. Thomas, Jr., Research Engineer, Arcos Corp., discussed recent efforts of A.W.S. and A.S.T.M. committee to classify and set up controls for classification of various types of stainless welding electrodes, and slides presented showed the rather limited range of current settings for various rod diameters. The effect of changes in current settings was well illustrated in pictures made of actual weldments. The title of Mr. Thomas' talk was "Welding and Oxy-Arc Cutting of Stainless Materials."

SYRACUSE

This Section held its February meeting on the 12th at the Syracuse Hotel. A. M. Setapen, of Handy and Harman, presented a very good address on "Low-Temperature Silver Alloy Brazing." A film on "Aluminum Resistance Welding" was also shown.

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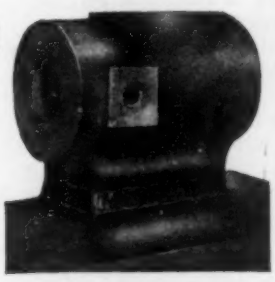

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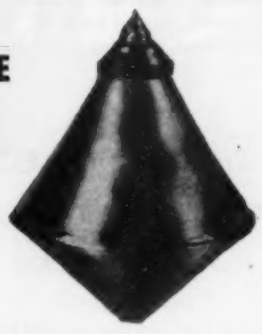

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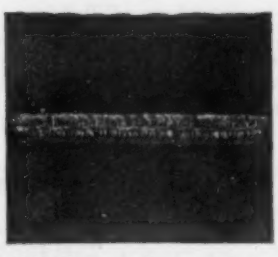
280



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18/8
25/12, 19/9
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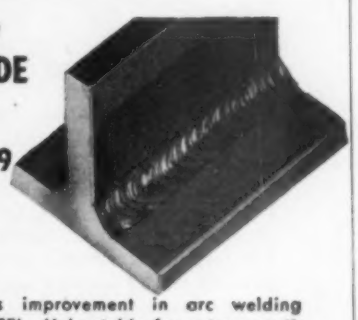

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Here's the most progressive way to tackle your difficult metal joining problems and at the same time make daily work easier and faster. If you are interested in EUTECTIC for oxy-acetylene ask for our catalog E-2. One of our 160 Field Engineers, nearest to you, will be glad to demonstrate these rods to you and help solve your problems.

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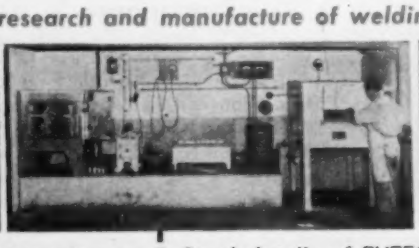
A unique organization devoted to research and manufacture of welding materials for all metals.



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WASHINGTON

The Washington Section held its regular February meeting at the Potomac Electric Auditorium on the 25th, with A. N. Kugler Air Reduction Sales Co., as the speaker on "Oxyacetylene Welding." Mr. Kugler discussed a number of new developments and created quite a bit of interest as evidenced by the discussion. Although attendance was held down by the inclement weather, those present enjoyed themselves and were taken by Mr. Kugler's always pleasant personality.

An unexpected guest was Harry W. Pierce, District No. 2 Vice-President. The Section was greatly pleased by the very kind remarks made by Mr. Pierce.

WESTERN MASSACHUSETTS

The February meeting was held on the 11th at the Sheraton Hotel. There were 95 present at the dinner and 125 at the meeting. Dinner speaker was Vincent T. Malcolm, Director of Research, Chapman Valve Manufacturing Co., who spoke on "Welding at the Chapman Valve Manufacturing Co." A film, "Long Life to Valves," was also shown. Both paper and film were excellent.

F. W. Davis, District No. 1 Vice-President, attended the dinner and meeting, as well as numerous out-of-town members and guests.

WESTERN NEW YORK

The important subject "Recent Trends in Arc-Welding Electrodes" was the subject of the January 23rd meeting. Dr. G. E. Claussen, of the Reid-Avery Co., Baltimore, discussed the various types of electrodes used in arc welding mild steel. The talk was illustrated with slow motion pictures of the welding arc. The photographs, taken at 3200 frames per second, showed details of metal transfer and arc action which cannot be shown by any other means.

A popular feature of Western New York meetings is the Coffee Talk, during which various members of the Local Section discuss their products and processes. R. S. Lane, of the Ross Heater and Manufacturing Co. discussed fabrication and uses of heat transfer units made by his company.

YORK-CENTRAL PENNSYLVANIA

Wednesday, April 16th is the date of the Annual Banquet and Dance at The Outdoor Club, 7:00 P.M. promptly.

P. D. Scott, General Sales Manager, Alloy Rods Co., York, Pa., was the speaker at the March 5th meeting. Mr. Scott's subject "Maintenance, Repair and Composite Construction of Tools and Dies" was well received.

CANADIAN

The fifth meeting of the 1946–47 season of the Montreal Chapter of the Canadian Welding Society was held on February 17th in The Engineering Building, McGill University. "Metallizing" was the subject presented by D. C. Boltz, Metallizing Engineer, Metallizing Engineering Co., Inc., New York City.

The Toronto Chapter held its March meeting on the 3rd at Malloneys Art Gallery. Forrest Nagler, Chief Engineer Allis-Chalmers Manufacturing Co., Milwaukee, Wis., spoke on "The Shipshaw Project."

The Hamilton Chapter held the sixth meeting of its series on March 4th at McMaster University. "The Stress Distribution in Welded Joints as Shown by Transparent Models Under Polarized Light" was discussed by L. C. McMurtry, Vice-President, Horton Steel Works, Fort Erie, Ont.

Employment Service Bulletin

POSITION VACANT

V-205. Welding Engineer with a flair for writing from a sales promotion point of view. Exceptional opportunity for right man.

SERVICES AVAILABLE

A-543. X-Ray Technician or Inspector desires position. Have thorough knowledge of Industrial Radiography. Have been in charge of X-Ray Department. Also in charge of Welders and Burners. Checked Radiographs, marked up sections for repairs. Experience in inspection of welding on pressure vessels and oil equipment.

SUSTAINING MEMBER

The Solar Aircraft Co. has its main office and plant at 2200 Pacific Highway, San Diego 12, Calif.; branch plants at 1900 Grand Ave., Des Moines 5, Iowa and Hubbard Casket Co., 2553 State St., San Diego 1, Calif.; and Sales Office at 60 E. 42nd St., New York 17, N. Y.

For sixteen years Solar Aircraft Co. has specialized in fabrication of products from stainless steel. During the war, the Company manufactured heat-resistant manifolds, cowlwells, shrouds, muffs, and heat exchangers for over one hundred leading types of airplanes. The postwar diversification program not only includes airplane exhaust manifolds and related equipment, but also jet and gas turbine sheet metal parts, stainless steel caskets, film processing machines and dairy equipment.

DH-MO ELECTRODES ANNOUNCED BY WESTINGHOUSE

For welding low-alloy cast steel or low-alloy high-tensile strength rolled steels in the flat position, with alternating-current or direct-current straight polarity, the new DH-MO electrode, available in four diameters from $^5/_{32}$- to $^1/_4$-in., is announced by Westinghouse Electric Corp.

This electrode is designed for high speed welding of grooved joints, positioned fillets and horizontal fillets. Welds made with the DH-MO electrode meet the requirements of A.W.S.-A.S.T.M. tentative specifications for Iron and Steel Arc Welding Electrodes, classification E-7020.

Further information on the DH-MO electrode may be secured from P. O. Box 868, Westinghouse Electric Corp., Pittsburgh 30, Pa.

MAGNAFLUX WELD INSPECTION CONFERENCE PLANNED FOR CHICAGO, MAY 8 AND 9, 1947

A conference called for the purpose of discussion of the use of magnetic particle inspection in the welding field is to be held at the Congress Hotel on May 8 and 9, in Chicago. It is planned to conduct the meetings on the basis of an open forum, with discussion leaders selected from the various fields in which this inspection method has found useful application. Fluorescent penetrant inspection as applied to the inspection of welds in nonmagnetic material will also be given a place on the program. The Conference will be held under the sponsorship of the Magnaflux Corp. Those interested in attending should write W. S. Thomas, of that company, at Chicago.

An outline of the program follows:

Thursday, May 8

Morning Session

9:30–12:45
Presentation of the fundamental consideration, both theoretical and practical, involved in the application of magnetic particle inspection to welding. Magnaflux Corporation Staff

Afternoon Session

2:15–3:30
Relation of magnetic particle to other methods used in the inspection of welds. Discussion Leader to Be Announced

3:30–5:00
Open discussion of subject matter presented during the day with panel consisting of the day's speakers

Friday, May 9

Morning Session

9:30–12:45
Open forum discussion of magnetic particle inspection problems in various specific fields, with a panel composed of a discussion leader for each field. Names of Leaders to Be Announced

Afternoon Session

2:15–3:15
General Discussion, with same panel as Morning Session.

3:30–4:00
Fluorescent Penetrant Inspection—What it is, how it works. Magnaflux Corporation Staff

4:00–5:00
General discussion of application of the Fluorescent Penetrant method to the inspection of welds. Discussion Leader to Be Announced

Saturday, May 10

Visit to Magnaflux Corporation Plant for those interested. Demonstration of equipment and methods.